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PROCEEDINGS OF THE AMERICAN CHEMICAL SOCIETY.

Regular Meeting January 5, 1883.

Meeting called to order at 8:50 P. M. Mr. Jas. H. Stebbins, Jr., in the chair. No quorum being present, business was dispensed with.

The following papers were then read by Dr. A. R. Leeds.

1. "On Xylidine-Acrolein."
2. "Cryptidine."
3. "On Oenanthol-Aniline; Oenanthol-Xylidine, and Oenanthol-Napthylamine."
4. "On the Products of Distillation of Castor Oil in Partial Vacuo."

After several questions by Dr. Friedberg and Mr. James H. Stebbins, Jr., a paper by F. B. Venable, Ph. D., "On Heptylmalonic and Heptylacetic Acids," was then read.

After proposal of several new members, the meeting adjourned.

THOMAS S. GLADDING, Cor. Secretary.

XYLIDINE-ACROLEIN.

BY ALBERT R. LEEDS.

In the Ber: d. D. Chem. Gesell. Vol. XV, p. 1158, I have shown that diphenylamin unites with acrolein to form the compound $(C_{12}H_{10}N)_2 C_3H_4$, one molecule of water being eliminated. Since that time I have examined the action of acrolein upon xylidine, the method of procedure being somewhat different. The acrolein was distilled directly into an alcoholic solution of xylidine, when a dark red precipitate was formed together with a large amount of a sticky resinous material. This precipitate is soluble in alcohol, ether and bisulphide of carbon. Finding that the resinous by-product was more soluble in dilute alcohol than the principal substance, the attempt was made to purify the latter by repeated washings with alcohol. It failed entirely. The entire removal of the adherent resinous material being impossible by this method.

When to an alcoholic solution of the impure mass, bromine is added in slight excess, a precipitation takes place of what is apparently a bromine compound of xylidine-acrolein. This compound is

soluble in benzole, chloroform, ether and alcohol, insoluble in bisulphide of carbon. It could not be crystallized from any one of these solvents, nor sublimed without decomposition.

Finally, after many unsuccessful trials, the following method was found to afford the xylidine-acrolein in a state of purity. Instead of distilling the acrolein directly into the xylidine, the acrolein in slight excess was added to an alcoholic solution of the latter body. The mixture was then digested for several hours upon a water-bath, until the smell of acrolein had almost entirely disappeared. The resulting mass, which was of a dark red color and extremely sticky, was freed as far as possible from the surrounding liquid, and boiled a number of hours with water. The longer it was boiled with water the less sticky it became, until finally it could be broken into small lumps and removed from the flask. These lumps were then pulverized in a mortar, returned to the flask and boiled with alcohol under a return cooler. This second boiling with alcohol had the result of taking out a large amount of the coloring-matter, but at the same time of making the mass sticky as before. The boiling with water and afterwards with alcohol had therefore to be repeated alternately many times, until at last a product was obtained quite insoluble in alcohol, and which was left hard and brittle after boiling with that solvent.

The purified body, which was of a reddish-yellow color, could not be made to crystallize from any solvent, nor did it yield crystallizable derivatives. As before stated, bromine enters into combination with it with great energy. Nitric acid converts it into a pastry mass that cannot be sublimed or crystallized.

The analysis gave N 8.49 per cent., (theoretical 8.8 per cent.) and showed that the substance was xylidine-acrolein, found according to the equation.

$$C_{15}H_{13}N = C_8H_{11}N + C_3H_4O - H_2O$$

ŒNANTHOL-ANILINE, ŒNANTHOL-XYLIDINE AND ŒNANTHOL-NAPHTHYLAMINE.

By Albert R. Leeds.

Œnanthol was prepared from castor oil by heating the oil in partial vacuo at a temperature of about 150°. The flask containing the castor oil was connected with a Liebig's condenser. As the volatile substances were distilled off they were condensed and

collected in a receiver connected with a Bunsen pump. The œnanthol was purified by subjecting the distillate to a second distillation and collecting that portion that came over at 154°. After two or three such treatments the œnanthol was obtained in a state of purity sufficient for the purposes contemplated in this article.

In preparing the following compounds molecular proportions were in each case used. 70 grms. of œnanthol and 57 grms. of aniline were gradually mixed together. The mixture became very hot ; the temperature rising from 27° to 89°. The resulting liquid mass is very mobile, much more so than either aniline or œnanthol.

In making the œnanthol-xylidine 70 grms. of œnanthol were added to 74 grms. of xylidine. The temperature rose from 27° to 85°, and the resulting product was also extremely mobile.

70 grms. of œnanthol were poured on to 88 grms. of naphthylamine.

The latter melted very rapidly and after combination had taken place the temperature of the liquid had risen to 75°.

All the three compounds were heated on the water bath under the return cooler for six hours to ensure complete combination. At the end of that time the flasks containing the three portions were removed and small portions taken from each which were subjected to distillation. The distillate in each case consisted of an uncombined base and some product of decomposition. The method of purification by distillation was thus far abandoned.

It was next found that the substances could not be purified by any solvent, since the œnanthol-aniline, œnanthol-xylidine, and œnanthol-napthylamine are as soluble in alcohol, ether, benzol, chloroform and carbon bisulphide, as their respective bases.

Eventually the most suitable process proved to be the following : Each of the three compounds was dissolved in about 150 grms. of glacial acetic acid and heated several hours on the water bath to ensure complete combination between the acetic acid and the excess of the bases aniline, xylidine, and napthylamine. When the bases were completely changed into their respective acetates, a large excess of water was added which threw down the œnanthol-aniline, etc., while the acetates remained in solution. The percipitated substances were thoroughly washed with water until every trace of acetic acid had disappeared. The three compounds were then dried at a temperature of 100°.

A portion of each of the three compounds was preserved for analysis while the rest was subjected to distillation.

The œnanthol-aniline as finally purified is a reddish-colored mobile liquid, having an agreeable ethereal odor, which resembles neither aniline or œnanthol. Its analysis yielded C 75.10 per cent., H 10.28 per cent., corresponding to the formula,

$$C_{13} H_2 NO = C_6 H_7 N\, C_7 H_{14} O,$$ in which

C is 75.36 per cent., and H 10.14 per cent.

The œnanthol-xylidine closely resembles œnanthol-aniline in appearance and smell. Its formula was found to be

$$C_{15} H_{25} NO = C_8 H_{11} N\, C_7 H_{14} O.$$

	Found.	Calculated.
C	76.94	76.59
H	10.00	10.64
N	5.93	5.96

The œnanthol-naphthylamine resembles the two preceding compounds in its appearance and properties, but was still more pronounced in its ethereal odor, which resembled that of pineapple.

Its formula is $C_{17} H_{23} NO = C_{10} H_9 N\, C_7 H_{14} O$.

	Found.	Calculated.
C	79.03 per cent.	79.38 per cent.
H	9.50 "	8.95 "

It will be noted that all these compounds formed synthetically by the direct union of one molecule of œnanthol with one molecule of the aromatic base, no water being eliminated, have a correspondingly elevated heat of combination. They are stable bodies, and were capable of sublimation, with only partial decomposition. The sublimates were not crystalline, and were identical in physical and chemical properties with the original substances, yielding on analysis the same formulæ.

SOLID RESIDUE FROM THE DISTILLATION OF CASTOR OIL IN VACUO.

By Albert R. Leeds.

In making œnanthol from castor oil there is always left in the flask a highly elastic, sticky substance, which was first investigated by Staněk (*Jour. Pr. Chem.*, Vol. 63, p. 138.) Although Staněk's results have never been accepted as conclusive, yet no one has reinvestigated the nature of this body, for which reasons I was induced to make the following research.

According to the recommendation of Krafft, Ber. Ber., Vol. x, p. 2034, the œnanthol was prepared by distilling castor oil in vacuo a pressure of about 100 m. m. being maintained. The operation must be watched very closely towards the end, because the residue in the retort, as soon as all the œnanthol has been driven off, liberates a large amount of gas which causes the caoutchouc-like mass to swell enormously and to fill the whole flask. Therefore, as soon as the bubbles of gas begin to appear, the vacuum is instantly relieved and the lamp removed. The residue, on the liberation of the gas, changes from a comparatively thin liquid to a very viscid mass that finally, on cooling, has almost the consistency of caoutchouc. It could not be entirely removed from the flask by mechanical means, and therefore, after as much as possible had been removed by a spatula, the remainder was saponified either with aqueous or alcoholic potash.

The caoutchouc-like mass was thoroughly washed, first with alcohol and then with ether, in neither of which is it at all soluble. Before washing, the substance is sticky and elastic, but the ether and alcohol remove all traces of stickiness, and most of the elasticity disappears. Long standing has the same effect, but in a lesser degree. The original color of the substance is a brownish-red, but after washing it becomes grayish-white with a very faint tinge of yellow. The analyses were made on the body thus purified.

In his analysis Staněk gives the formula $C_{42}H_{68}O_5$ as calculated from C 77.11 per cent. H 10.77 per cent. and O 12.12 per cent. The percentages as found by me were : C 76.47 per cent. H 10.69 per cent. and O 12.84 per cent.

The caoutchouc-like body by long continued boiling with aqueous or alcoholic potash is completely saponified. All the residues obtained were saponified, the solutions filtered hot, and the filtrates decomposed by hydrochloric acid. The organic acid in combination with potash, after decomposition by a mineral acid, presents none of the characteristics of the original caoutchouc-like mass. On the contrary, it is an oily body lighter than water, and has a reddish-brown color. The oil is extremely soluble in alcohol and ether, and insoluble in water. It was purified for analysis by dissolving in ether, after repeatedly washing with hot water, filtering, evaporating off the ether and drying at 100°.

The purified oil on analysis gave : C 70.22 per cent, H 11.04 per cent. O 18.74 per cent. Staněk in his analysis of the same oil, prepared by a slightly different method, found C 70.40 per cent, H

11.00 per cent, O 18.60 per cent, from which he deduces the formula $C_{36} H_{68} O_7$.

In the acid filtrate from the oil decomposed by hydrochloric acid, no glycerine could be found, but only a small amount of a resinous body which was not investigated. This result also corresponds with that obtained by Staněk.

A considerable amount of the oil was subjected to fractional distillation. When heated, the oil turns black and is decomposed, yielding at ever-increasing temperatures a distillate of light and almost colorless oils that have a very pungent and peculiar though not a disagreeable odor. These oils come off at points ranging from 110° to 250°. They were collected in three separate portions, having boiling points from 110° 150° 160° 200° and above 200°. Each portion was distilled three times, and finally three were taken whose boiling points were 120° 180° and 220° C.

Their analysis yielded :

	120°	180°	220°
Carbon.....	68.20	68.89	68.85
Hydrogen.....	11.29	12.60	11.50
Oxygen.....	20.51	18.51	19.65

These oils do not form salts with potash or soda. On exposure to light and air they turn darker from absorption of oxygen.

Nitrogen was sought for in all of the oily products of the caoutchouc-like substance, but its presence in any could not be established.

The results above given do not bear out the views of Staněk with regard to the constitution of the caoutchouc body and its derivatives. Staněk assigns the formula $C_{42} H_{68} O_5$ to the caoutchouc body, and terms it an Acryloxide compound consisting of his Pyroricinic Acid and Acrolein.

$$C_{42} H_{68} O_5 = C_{36} H_{60} O_2 + C_6 H_8 O_2.$$

In this case the compound ought to contain Acrolein which it does not. No Acrolein could be detected either in the process of saponification or of distillation.

In the next place, the Pyroricinic Acid of Staněk which he regards as a fatty acid, although it has no analogies to any known series of fatty acids, is first formulated as $C_{36} H_{68} O_7$. It was made by converting the oil obtained by saponification of the caoutchouc body, into a lead salt. But this body after keeping for three days at a temperature of 100°, became (according to Staněk). $C_{36} H_{58} O_2$. He furthermore states that the water which thus came off did not

exist in the original acid in the form of water, inasmuch as the correct formula of this acid should be regarded as $C_{26} H_{62} O_4$.

I have not attempted to give rational formulæ for the caoutcho u body or for its oily distillates. I have merely given these resultsc the obtaining of which involved very considerable labor on my, own part and that of my assistant Dr. Edgar Everhart, in the hope that some one will repeat the work with such large quantities of material as eventually to obtain by fractional distillation or otherwise, homogenous products.

CRYPTIDINE.

BY ALBERT R. LEEDS.

When xylidine-acrolein, prepared as stated in a preceding article was subjected to dry distillation some oily drops of peculiar smell were given off. A considerable amount of this substance, therefore, after careful purification was thoroughly dried at a temperature of 110° and finely pulverized. Small portions of about 20 grms. each were introduced into a small tubulated retort, placed in an air-bath and subjected to distillation, carried on very slowly to avoid carbonization. No record could be taken of the temperature of the distillation since it exceeded 360°. At first, before decomposition set in, a small amount of water came over which was of a slightly acid reaction, and which was rejected. When the temperature rose higher and decomposition began, a distillate composed of oily drops mixed with water of an alkaline reaction, came over. The residue in the retort consisted of a porous carbonaceous mass, extremely difficult of combustion. The alkalinity of the distillate, was due to free ammonia given off in considerable quantities during the operation, the retort at the end being filled with its fumes.

About 155 grms. of the xylidine-acrolein were thus distilled in small portions at a time and the distillates collected. The water was separated from the oil by filtering through a wet filter, and heated for several hours at a temperature of 100° till the weight was constant. The yield from 155 grms. of the xylidine-acrolein was 11 grms., or a little over 7 per cent.

Several unsuccessful attempts were made to purify the distillate, but no constant boiling point could be obtained. A small amount

of carbonaceous residue was left in the distilling flask at the close of each experiment.

The crude oil has a disagreeable smell and a very bitter taste. It forms crystalline salts with acids; sulphuric, hydrochloric, acetic, etc. Finally, the best method of purification was found to be that of decomposing its hydrochloric acid salt by means of alkali. The mother liquor, obtained by treating the oil with hydrochloric acid and consisting of a bad-smelling, thick liquid, was drained off from the crystals, and these were further cleaned by pressing between filter paper. The crystals were then dissolved in a small amount of water and filtered from an insoluble oily scum. The aqueous solution was allowed to crystallize, and the crystals were treated in the same way until quite pure. Finally the aqueous solution of the salt was decomposed with a little caustic potash. The precipitated oil was freed from the alkali, by repeated washing with water, filtered and thoroughly dried at 100°. The dried and purified oil was redistilled at 270° a boiling point that remained constant. It is reddish yellow in color, and possesses a disagreeable odor.

The final analysis was made on this product and gave a formula corresponding to cryptidine, $C_{11}H_{11}N$

	Found	Calculated
C	84.45 pct	84.08 pct.
H	7.38 pct	7.00 pct.
N	8.99 pct	8.92 pct.

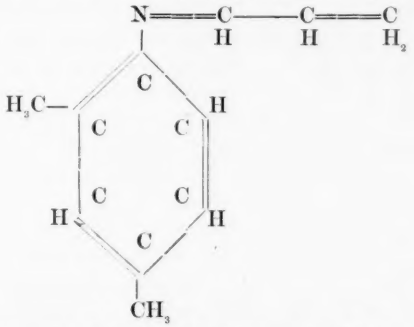
The hydrochlorate crystallizes in fine thin, colorless, tubular crystals which may, by careful heating, be sublimed, although a partial decomposition takes place. On analysis it yielded 18.04 per cent. Cl, theory 18.34 per cent. required.

When to an aqueous solution of the hydrochlorate a solution of platinic chloride is added, there is instantly a precipitation of a fine yellow crystalline compound of the double salt of cryptidine and platinic chloride. The double salt is soluble in water, but is precipitated on the addition of platinic chloride in excess. It was purified by washing with alcohol in which it is insoluble and crystallizing from water.

It will be noted that this is the first successful attempt to form cryptidine synthetically, and that it likewise yields the oil directly and in a state of purity.

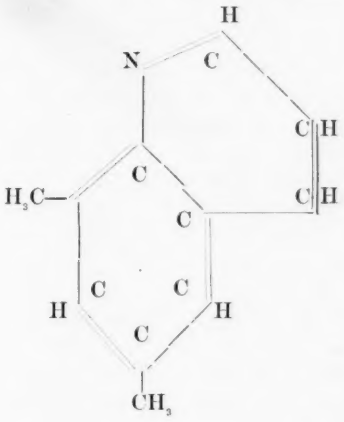
This synthetic formation of cryptidine, affords a valuable opportunity of obtaining an insight into its probable structural con-

stitution. The constitution of xylidene-acrolein, it was the meta compound which was employed, might be represented as



The oxygen of the acrolein is represented as combining with the two atoms of the nitrogen, in order to account for the fact that the metaxylidene-acrolein is entirely devoid of basic properties, and cannot be made to form salts. On heating, two atoms of hydrogen are given off, one from the extremity of the acrolein chain the other from the benzene ring. This being the case, the extremity of the chain is brought round to form by the union of the bonds thus opened another ring.

In other words the Cryptidine would contain the benzene ring, and a side ring with the N atom occupying the usual position of the C atom, the bonds being probably distributed as in the annexed diagram.



HEPTYLMALONIC AND HEPTYLACETIC ACIDS.

F. P. Venable, Ph. D.

A brief mention of the preparation of these two acids has already been made (Ber. XIII., 1657). I have since utilized the small amount of the acids which I had on hand in the preparation of some new salts, and will give a description of them, as they serve to characterize these acids more fully than was done in the previous notice.

Heptylmalonic Acid $C_{10}H_{18}O_4$.

This acid belongs to the oxalic acid series and is an isomer of sebacic acid. It can be prepared from heptylmalonic ether. The simplest decomposition of this ether by means of an alkali is of course the breaking up into alcohol and heptylmalonic acid. We can look upon the reaction as taking place in accordance with the following formula :

$$C_{10}H_{16}O_4(C_2H_5)_2+2HOK=C_{10}H_{16}O_4K_2+2C_2H_5OH.$$

An alcoholic solution of potassium hydroxide was used. A small portion of the ether and four times the theoretical amount of potassium hydroxide were heated four to six hours in a small flask upon the water bath. At the close of the reaction water was added, and then hydrochloric acid, and the whole gently heated. The heptylmalonic acid separated as a brown-colored oil on the surface of the water. This was then shaken with ether, allowed to stand for evaporation of the ether and the residue placed in a desiccator over sulphuric acid. The mass solidified, but was still a yellow color, and after drying gave the melting point at 90–93° C. In order to free the acid from all impurities it was washed well with petroleum ether. It proved almost insoluble in this liquid, and was left as a white crystalline mass, melting by 97–98° C. (uncorrected). It is but slightly soluble in water, but easily so in alcohol, chloroform and ether. The solution has a strongly acid reaction. Analyses were made as follows :

I.	0.1432 grm. of acid taken	% C=59.76	% H=9.01.
II.	0.1557 grm. of acid taken	% C=59.59	% H=9.04.
	Calculated for $C_{10}H_{18}O_4$	% C=59.41	% H=8.91, % 0=31.98.

The acid is dibasic and capable of substituting carbonic acid in the cold. Heated to 130–160° C. it breaks up into heptylacetic

acid and carbon dioxide. The salts crystallize very indistinctly, if at all, and are easily soluble only in the case of the alkalis.

Silver Heptylmalonate.

An aqueous solution of ammonia was added to the acid until nearly neutralized, and the ammonium heptylmalonate formed in this way was added to a solution of silver nitrate, causing a white precipitate of silver heptylmalonate. The precipitate is heavy and white, seemingly composed of minute, indistinct crystals, and is quite insoluble in water, whether cold or hot. Alcohol also fails to dissolve it appreciably. It was dried in a steam-bath to a constant weight. Only after long keeping does it change to a reddish brown. The melting point, as determined with a portion only slightly changed in color, was 244° C. Two determinations of silver were made.

I. 0.4330 grm. silver salt taken, % Ag=51.34.
II. 0.3904 grm. silver salt taken, % Ag=51.56.
Calculated for $C_{10}H_{16}O_4Ag_2$. % Ag=51.92.

Barium Heptylmalonate.

As in the case of the silver salt, this was obtained as a precipitate from barium chloride by means of ammonium heptylmalonate. It is a white amorphous powder, insoluble in water and alcohol. The salt was dried at 100° C. and analyzed. It can be heated to 160° C. without suffering decompositi n.

I. 0.3002 grm. barium salt taken, found % Ba=40.19.
II. 0.5133 grm. taken, found % Ba=40.45.
Calculated for $C_{10}H_{16}O_4Ba$. % Ba=40.65.

Copper Heptylmalonate.

The ammonium salt was not used in the preparation of this compound, but the acid itself (slightly impure) dissolved in water and added to a concentrated solution of pure cupric sulphate. The impure acid was used because the traces of impurity made it much more soluble in water, and the nature of the impurity did not seem to interfere with the formation of the cupric salt. The addition of the acid caused a light-blue precipitate, which was washed well with water. As it was somewhat soluble in water, an excessive use of this had to be avoided. It is more soluble in alcohol, and on evaporation is left behind as an indistinctly crystalline mass. On standing several days over sulphuric acid it becomes almost dry

and loses at 100° C. the last traces of water. On further heating it suffers no loss in weight, until at quite a high temperature it begins to turn brown and decompose. It seems therefore to contain no water of crystallization.

Analysis :

0.3253 grm. taken, found % Cu=23.80.
Calculated for $C_{10}H_{16}O_4Cu$. % Cu=24.04.

Lead Heptylmalonate.

Alcoholic solutions of heptylmalonic acid and lead acetate were made, and on mixing them a heavy white precipitate formed. This precipitate wes repeatedly washed with water, and some of the last washings were evaporated, yielding scarcely any residue, thus showing the almost entire insolubility of the lead heptylmalonate in that solvent. In alcohol it is slightly soluble. After thorough washing, the precipitate was dried in the steam-bath ; drying at 110° C. caused no further loss in weight. A portion of the dried salt was taken for a determination of the melting point ; melting at 235° C. The remainder of the precipitate, amounting to nearly 0.2 grms , was taken for analysis. It was dissolved in dilute nitric acid and the lead determined by evaporation with sulphuric acid.

Analysis :

found, % Pb=50.49.
Calculated for $C_{10}H_{16}O_4Pb$, % Pb=50.89.

Zinc Heptylmalonate.

On adding an alcoholic solution of the acid to one of zinc acetate the whole mass gelatinized, very much like silicic acid. It is stiff and can be cut or broken up with the stirring rod. This jelly-like mass was first washed with alcohol and then boiled with water, becoming compacted, white and flaky and easy to wash. It is somewhat soluble in water when in this form, more so in hot than in cold, separating from a hot solution on cooling in minute crystals. Some of these crystals dried on filter paper were found to melt at 247° C. The rest of the precipitate was collected in a crucible, dried on water-bath and weighed. On heating at a higher temperature, 140°–170° C., slight loss in weight was noticed. This loss was continuous, and resulted from commencing decomposition. The exact temperature at which the decomposition commenced was not determined. The salt is also easily soluble in ammonium hydrate.

The zinc was determined by dissolving in dilute hydrochloric acid and precipitation as carbonate.

Analysis:

I. 0.1298 grm. salt taken, found % Zn=24.49.
II. 0.0411 grm. salt taken, found % Zn=24.33.
Calculated for $C_{10}H_{16}O_4Zn$ % Zn=24.52.

Heptylacetic Acid, $C_9H_{18}O_2$.

According to the researches of Wisliceuns (Annalen, 190.267), ethers of the aceto-acetic series can undergo two different decompositions on treatment with alkalis—one resulting in the formation of alcohol, potassium carbonate and a ketone, the second in the formation of alcohol, potassium acetate and a mono-basic acid. In preparing heptylacetic acid from the heptylaceto acetic ether the methods of Wisliceuns were closely followed, yet it was found impossible to bring about any one decomposition unaccompanied by a partial decomposition in accordance with the second formula. In preparing the acid then, traces of methylactyl ketone were formed at the same time. The mode of preparation was as follows. Four times the theoretical amount of a concentrated alcoholic solution of potassium hydroxide was added to the heptylaceto-acetic ether placed in a flask connected with an inclined condenser, and the mixture heated six hours upon the water bath. The main portion of the alcohol was then distilled off, dilute hydrochloric acid added to the solution left behind, and the heptylacetic acid separated immediately as a brownish thick oil on the surface of the liquid. This oil was washed with water and dried over calcium chloride. As the heptylacetic ether could be procured with difficulty, and the product of acid from its decomposition was very unsatisfactory, it was found more convenient to prepare the acid from the heptylmalonic acid already mentioned.

As is well known, all diatomic, dibasic fatty acids, which have the two carboxyles joined to the same carbon atom, fall on heating into carbon dioxide and a monatomic, monobasic acid. Thus oxalic acid (where the two carboxyls are united to one another) yields on rapid heating carbon dioxide and formic acid. Malonic acid yields carbon dioxide and acetic acid. Heptylmalonic acid, then, should yield carbon dioxide and heptylacetic acid. The heating was done in a small flask with condenser inclined and its open end connected with a pipette which just dipped beneath the surface of some water

in a beaker. In this way the evolution of carbon dioxide, and hence the progress of the reaction, could be watched. The flask was heated in a bath of paraffine. The heptylmalonic acid first melted, then at about 130° C the evolution of carbon dioxide commenced, at 150° C the evolution was quite rapid. The temperature was finally raised to 170° C to complete the reaction, the condenser was then inverted and the dark oily fluid left in the flask fractioned. Up to 220° C nothing, distilled over, then a few drops to 228° C, and the greater part of the acid came over at 232–233° C. The pure acid was found to boil at 233° C. It is a colorless, oily liquid, with somewhat of the characteristic smell of the acetic ethers, though not so pleasant. It is nearly insoluble in water, but easily soluble in alcohol and ether. Cooled to 23° C, it becomes viscous, but does not solidify. Analyses were made as follows:

Analyses:

I. 0.2033 grm. acid taken, found	% C = 67.97;	% H = 11.64.
II. 0.1116 grm. acid taken, found	% C = 68.11;	% H = 11.70.
Calculated for $C_9H_{18}O_2$ acid taken	% C = 68.35;	% H = 11.40.

This acid is an isomer of pelargonic acid, and is monobasic. Towards litmus its reaction is faintly acid, and only by aid of heat is it capable of decomposing carbonates. With the metals it forms salts which are, as a rule, non-crystalline and difficultly soluble in water. They are fairly stable when heated, decomposition not taking place generally until a temperature considerably above 100° C. has been reached.

Calcium Heptylacetate.

It was found best to make this salt first and use it in preparing others which were deemed of value in characterizing the acid. Heptylacetic acid was suspended in water and boiled with an excess of calcium carbonate. Bubbles of carbon dioxide were noticed, but the action was slow. The filtered solution, smelling strongly still of the acid, was placed over sulphuric acid in a desiccator. After some days a crust formed over the surface, but no crystals were observed. By further evaporation a white powder was obtained if a good deal of the salt was present, otherwise a dry transparent crust. This was thoroughly dried at 100° C. The salt is not very soluble in water, nor in alcohol. Hydrochloric acid dissolves it with the separation of the acid. The analysis was carried out by simple ignition.

Analysis :

0.1181 grm. salt taken ; found % Ca = 11.38.
Calculated for $(C_9H_{17}O_2)_2Ca$ % Ca = 11.29.

Silver Heptylacetate

was gotten as a heavy white precipitate by adding silver nitrate to the aqueous solution of the calcium salt. This was filtered off and washed well with water, alcohol, and finally ether, and dried in the steam-bath. It is nearly insoluble in cold water, very slightly more soluble in hot, and not perceptibly soluble in either alcohol or ether. There was no loss in weight nor change of color from heating in the steam-bath, nor in the air-bath as high as 130° C. Between 200° and 220° C complete decomposition takes place. Long continued exposure to the light changes the color, though not very deeply.

Analysis :

I. 0.3065 grm. salt taken ; found % Ag = 40.88.
II. 0.2910 grm. salt taken ; found % Ag = 40.65.
Calculated for $C_9H_{17}O_2Ag$ % Ag = 40.76.

Barium Heptylacetate.

This salt was gotten by the direct action of the acid, suspended in water, on barium carbonate. It is somewhat soluble in water and rather more soluble in alcohol. A saturated aqueous solution remained some days over sulphuric acid in a desiccator from which most of the air had been withdrawn, but no crystals were obtained.

The solution was then evaporated to dryness, and the white powder left heated in an air bath to 150° C. without loss of weight. In determining the barium the salt was slowly and carefully tested till the residue was nearly white, ammonium carbonate was then added and the whole again heated until a constant weight was obtained.

Analyses :

I. 0.3042 grm. salt taken ; found % Ba. = 30.13.
II. 0.1970 grm. salt taken ; found % Ba. = 29.55.
Calculated for $(C_9H_{17}O_2)_2Ba$. % Ba. = 30.38.

Copper Heptylacetate.

To prepare this ammonium heptylacetate was first made by treat- the acid with an aqueous solution of ammonia. The solution of this was then added to a cupric sulphate solution and the greenish-

blue precipitate, gotten in this way, washed well with water. It was then dissolved in alcohol and after slow evaporation of the alcohol there was left instead of crystals a few deep green oily drops on the bottom of the dish. Minute crystals could be gotten however, in the form of a precipitate by slowly adding water to the alcoholic solution. An analysis showed the purity of the compound.

Analysis:

0.2262 grm. salt taken; found % Cu = 16.53.
Calculated for $(C_9H_{17}O_2)_2Cu$. % Cu = 16.78.

Zinc Heptylacetate.

The first mode of preparation attempted was by adding a solution of calcium heptylacetate to one of zinc acetate. This gave a white cloudy precipitate which settled slowly. It was washed with water and then with alcohol. It seemed somewhat more soluble in alcohol than water, though not very soluble in either. On drying in the steam-bath after washing with alcohol, a white sticky mass was left, continued drying at 100° C. however, caused no further loss in weight. The analysis made of this precipitate showed only an approximate purity, the percentage of zinc being too high. A different mode of preparation was then tried. The acid, suspended in water, was boiled with freshly precipitated zinc carbonate. A slight solution of carbon dioxide was noticed, an excess of acid was added and the boiling was long continued. Analysis of the product finally showed by the high percentage of zinc, that much of the zinc carbonate remained unacted upon. A last attempt with the small remaining portion of the acid was made by dissolving it in alcohol and adding to it an alcoholic solution of zinc acetate. This caused a slight turbidity only, as both the acetate and the heptylactetate of zinc are soluble in alcohol. The acetate, however, is more soluble in water than in alcohol, just the reverse being true, apparently, for the heptylacetate. On adding water, then, to this solution of the two in alcohol, a cloudy white, slowly settling precipitate was gotten. The amount however was too minute for any reliance to be placed upon an analysis, hence none was attempted.

The ammonium salt and the potassium salt of this acid was made incidentally for the preparation of other compounds by saturating the acid with solutions of ammonium and potassium hydroxide respectively. They seemed easily soluble in water and in alcohol, but gave no good crystals and were not analyzed.

ABSTRACTS.

Abstracts from *Berichte der Deutschen Chemischen Gesellschaft*, by Percy Neymann, Ph. B.

The Action of Sodium on Lupinin. G. BAUMERT. (Vol. XV., p. 631).—Partly controversial. From a series of experiments it is shown that when sodium acts on lupinin a sodium substitution product is formed, which, in contact with water, exchanges the sodium for hydrogen, hence acting like a sodium alcoholate.

Anhydrolupinin. G. BAUMERT. (Vol. XV., p. 634). Anhydrolupinin was produced by the action of phosphoric acid anhydride and lupinin chloride, by heating five to six hours to about 190° C.

On the Acids produced from Xylols and Phtalic Acid Anhydride. FRANZ MEYER. (Vol. XV., p. 636). The new acids may be regarded as hydrocarbons, into which the group $COOH.C_6H_4.CO$ has been introduced. Orthoxylal-phtaloylic acid from ortho-xylol and phtalic acid anhydride has the formula :

$$C_6H_3 : \begin{matrix} CH_3\,(1) \\ CH_3\,(2) \end{matrix} — CO.C_6H_4.COOH.$$

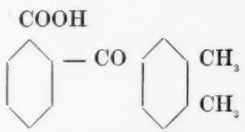
Metaxylol-phtaloylic-acid from one part of phtalic acid anhydride to three of metaxylol in presence of one and one-half parts of aluminium chloride has the formula :

$$C_6H_3 : \begin{matrix} CH_3\,(1) \\ CH_3\,(3) \end{matrix} — CO.C_6H_4COOH.$$

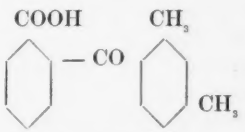
Paraxylol-phtaloylic-acid from paraxylol and phtalic acid anhydride has the formula :

$$C_6H_3 : \begin{matrix} CH_3\,(1) \\ CH_3\,(4) \end{matrix} — CO.C_6H_4COOH.$$

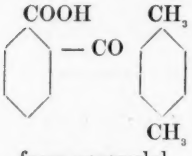
The constitutional formulæ of the three acids would hence be :



from orthoxylol



from metaxylol



from paraxylol

On Mesitylenphtaloylic Acid. J. Gresly and F. Meyer (Vol. XV., p. 639).

$$C_6H_2 \begin{cases} CH_3\ (1) \\ -CH_3\ (3) \\ CH_2\ (5) \end{cases} - CO.C_6H_4.COOH.$$

The action of phtalic acid anhydride on mesitylen in presence of chloride of aluminium is analagous to that on metaxyl. Analyses correspond to the formula $C_{17}H_{16}O_3$.

On the preparation of Aromatic Phosphoric Acid Ethers. A. Weber and R. Heim. (Vol. XV., p. 639). Phenols can be converted into amines and into the aromatic ethers, but the substitution of the hydroxyl group is often found to be very difficult. The authors find that by means of phosphorous oxychloride the ethers can be formed with comparative ease.

On the action of Acetylchloride and Glacial Acetic Acid on Fumaric Acid and on the Decomposition of the Monosubstituted Succinic Acid Anhydrides. R. Anschuetz and C. Bennert. (Vol. XV., p. 640).—14 grms. of acetylchloride, 28 grms. of glacial acetic acid, and 10 grms. of fumaric acid, when permitted to act upon each other for twelve hours, give a clear, light yellow liquid which, when subjected under ordinary pressure to distillation separates hydrochloric acid copiously, and maleïnic acid anhydride distills over. If the distillation is performed under diminished pressure (11 to 12 mm. mercury) acetyl-chloride, acetic acid and acetic acid anhydride distill over at first; at 80° maleïnic acid anhydride begins to come over until at 125° to 126° a colorless liquid distills over, which becomes hard. This body was found by analysis to be monochlorsuccinic acid anhydride. Acetylchloride and glacial acetic acid react upon each other in such a manner when boiled that by the evolution of hydrochloric acid acetic anhydride is formed. The hydrochloric acid attaches itself to the fumaric acid and forms monochlorsuccinic acid. The latter

is converted into monochlor-succinic acid anhydride by acetyl-chloride.

On Oxalines and Glyoxalines. O. WALLACH. (Vol. XV., p. 644).—Preparation and description of methylglyoxaline, propyl-glyoxaline, amylglyoxaline, and some of their salts.

On the action of Acid Chlorides and Bromides on Chinones. H. SCHULZ. (Vol. XV., p. 652).—The experiments gave reason for the conclusion that acid chlorides and bromides act in a similar manner on chinones as hydrochloric and hydrobromic acids; chloridized or bromidized hydrochinonethers are formed. It must be assumed that the respective chlorine or bromine anhydrides split up into the free halogen and the acid radical; the latter attaches itself to the chinon, and hydrogen atoms of the generated hydrochinonether are substituted by the free halogen.

On the production of active Oxygen. MORITZ TRAUBE. (Vol. XV., p. 659).

On Condensation Products of Aromatic Bases. OTTO FISCHER. (Vol. XV., p. 676).—The aldehydes were made to act either upon the sulphuric or phosphoric acid salts of the aromatic amines in place of, as heretofore, upon the hydrochloric acid salts. The contents of the article give more contributions to the manifold condensations of aldehydes and bases.

Note on Alpha-oxychinolin. KARL BEDALL and OTTO FISCHER. (Vol. XV., p. 683).

On Basic Acetate of Magnesium. W. KUBEL. (Vol. XV., p. 684).—Acetate of magnesium when warmed with an excess of magnesia in aqueous solution is converted into the basic salt in the same manner as lead. The basic acetate of magnesium is highly antiseptic, disinfecting, and especially deodorizing. A solution of basic acetate, somewhat cloudy from the presence of basic magnesium acetate, is known in commerce as sinodor.

On the Compounds of Naphtochinon with Toluidin and Ethylanilin. LEO ELSBACH. (Vol. XV., p. 685).—The ideas of Liebermann regarding the conversion of beta-naphto-chinon-anilid into alpha-naphto-chinon-anilid gave reason to the supposition that other aromatic aminebases could react in a similar manner on beta and alpha-oxynaphtachinon, and that two series of amid compounds

would be formed by the two chinones. The author experimented with para-toluidin and the two naphto-chinones and oxynaphto-chinones, and verified the supposition completely. Orthotoliudin was tried in the same manner, but the operations were performed with much greater difficulty. Experiments with an imid base also proved the correctness of the constitution formula set up by Liebermann.

On a new method of preparing Alizarin-Orange. S. E. Simon. (Vol. XV., 692).—Dinitro-oxy-anthraquinone is suspended in boiling water and a small quantity of concentrated caustic soda solution is added. A dark red sodium salt is formed. The solution is concentrated until a flocculent precipitate begins to fall. This is filtered, washed with alkali, and treated with hydrochloric acid. The yellow precipitate is crystallized from glacial acetic acid. The analysis shows the product to be mono-nitro-alizarin. The reaction takes place in correspondence with the following equation :

$$C_{14}H_5O_2\,(OH)\,(NO_2)_2 + KOH = KNO_2 + C_{14}H_5O_2\,(NO_2)\,(OH)_2.$$

A portion of the nitro group escapes in the form of ammonia.

On the Reducing Properties of Living Protoplasma. O. Loewand, Th. Bokarny. Vol. XV. p. 695. Controversial.

Synthesis of Para-propyl Benzoic Acid. Richard Meyer and Erwin Mueller. Vol. XV., p. 698. Para-normal propyl-benzoic acid was obtained by the action of moist carbonic acid on brom-propyl-benzol and sodium. The analysis suggests the formula $C_{10}H_{12}O_2$.

Preparation of Lactic Acid. Heinrich Kiliani. Vol. XV., p. 699. The results of experiments are : 1. The best crude material is invert sugar ; 2. Caustic soda is best ; 3. It is not advantageous to neutralize the entire alcoholic solution with carbonate of zinc. A detailed method of manipulation is appended.

Contribution to the Knowledge of Saccharin. H. Kiliani. Vol. XV., p. 701. Calcium hydrate acts on invert sugar and forms lactic acid. Saccharin was produced as by product. A treatment with oxide of silver shows saccharin to differ in its reactions with this reagent from dextrose and levulose. These, as the author has previously shown, when oxidized in this manner, produce glycolic acid only, besides carbonic, oxalic and traces of formic

acids, while from saccharin acetic acid is produced in addition to this acid. This result seems to point out that saccharin contains a methyl group moreover, because when oxidized with potassium permanganate, not only carbonic acid and water, but also acetic acid are formed.

On the Molecular Structure of the Metals. S. KALISCHER. Vol. XV., p. 702. An elaborate paper, giving the results of experiments with the most common metals. The results of all the enumerated experiments may be gathered thus: that the crystalline structure of most metals is their natural condition, and that this may be taken from them, with more ar less difficulty (from some not at all), by mechanical effects, and that many of them can be reconverted into this condition by the aid of heat. By assuming this, the cause of the great electrical conducting power of metallic wires, which they assume after being heated, can be explained.

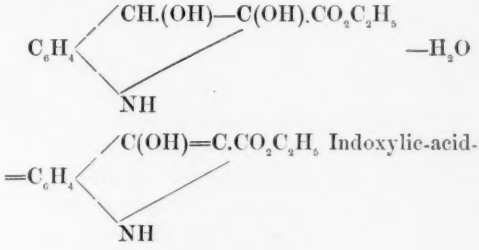
On Isocholic Acid. P. LATSCHINOFF. Vol. XV., p. 713. Partly controversial. The author gives various points showing the difference between cholic and isocholic acids.

On the Action of Bromine in Alkaline Solutions on the Amides. A. W. HOFMANN. Vol. XIV., p. 2725. Vol. XV., pp. 407, 752, 762.

On the Compounds of the Indigo Group. ADOLPH BÆYER. Vol. XV., p. 775. By oxydation of indoxylic-acid-ether by means of acid oxydizing agents three consecutive stages are observed:

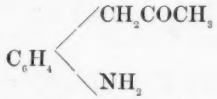
Indoxylic-acid-ether ..... $C_{11}H_{11}NO_3$
Indoxanhydic-acid-ether ..... $C_{22}H_{20}N_2O_6$
Indoxanthinic-acid-ether ..... $C_{11}H_{11}NO_4$
Ethyl-oxalyl-anthranilic acid ..... $C_{11}H_{11}NO_5$

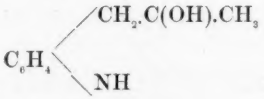
Reduction of indoxanthinic-acid-ether takes place in two stages when heated with zinc-dust and acetic acid.



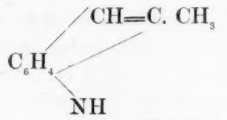
Indoxylic-acid-ether.

corresponding to the formation of methyl keton from amido-bezyl-methyl-keton.



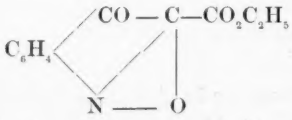


Ami do-benz yl-methyl-keton



Methylketon.

The constitution given to isatogenic-acid-ether is shown by the formula.



Hence a group $\begin{matrix} N—C \\ \diagdown\ \diagup \\ O \end{matrix}$ is taken up. The author terms this the "carbazoxy group." The action of nitrous acid on the various indoxyl compounds is also discussed by the author. The relations of the indol to the to the indoxyl group are as yet uncertain.

On Monochlorocinamic Acid. G. W. Jutz. Vol. XV., p. 788. By proper treatment of phenyl-dichlor-propionic acid with potassium tartrate, true potassium-chloro-cinamates are formed. They are separated by difference of solubility in alcohol. From the salts two acids were obtained. Monochloro-cinamic-acid melting at 142° –143°, and chloro-cinamic-acid at melting at 114°.

Investigations on the Diffusion of some Organic and Inorganic Compounds. J. D. R. Scheffer, Vol. XV., p. 788.

On Di- and Tri-Phenylphosphin. A. Michaelis and L. Gleichmann. Vol. XV., p. 801. Diphenyl-phosphin is formed bp treating diphenyl phosphin chloride $(C_6H_5)_2PCl$ with water, or dilute solution of caustic soda, diphenyl-phosphinic acid or its sodium salt being formed at the same time :

2 $(C_6H_5)_2$ PCl+2 H_2O=$(C_6H_5)_2$ PH+$(C_6H_5)_2$ PO.OH+2 HCl. Triphenyl-phosphin $(C_6H_5)_3P$ is formed when a solution of phosphenylic chloride and brombenzol is left in 3 to 4 times the volume of ether (free from water) with thin strips of sodium. This left to itself for 6 or 10 days at the common temperature, $C_6H_5PCl_2$+2C_6H_5Br+ Na=$(C_6H_5)_3$ P+2NaCl + Na Br.

On Beta-Naphtol-Aldehyd. G. KAUFFMANN. Vol XV., p. 804. 40 grms. of beta-naphtol are dissolved with 60 grms. of caustic soda in 250 grms. of water and heated on a water bath with 50–60 grms. of chloroform at an upright condenser for several hours. Three compounds are formed. Petroleum benzene dissolves out the aldehyde and a second compound. These two may be separated by acid of caustic soda solution in which this second substance is insoluble. The aldehyde is purified by driving off with steam. The experimenter then formed an acid in order to characterize the aldehyde. A di-naphthol is also formed.

Note on artificially colored claret wines. P. PASTROVICH, (Vol. XV, p 808.)

Presence of fuchsin is detected by treatment of the wine with oxide of manganese (braunstein). The wine is not deprived of its color when colored with fuchsin and treated in the above manner 2 mgs. of fuchsin to the litre can be detected.

On the bases produced from the products of addition of chinolin and halogenalkyls. W. LA CASTE, (Vol. XV, p 809.) Controversial.

On the action of lead and manganese dioxides on halogen metals in presence of acetic acid. C. L. MUELLER and G. KIRCHNER, (Vol. XV, p 812.) Controversial.

The chlorine liberated from hydrochloric acid by means of the binoxide of lead seems to convert the acetic acid into monochloroacetic acid and this again by the formation of lead chloride, carbonic acid and free chlorine is farther oxidized. An aqueous solution heated with $Pb\,O_2$ produces the products enumerated and after continued boiling of Na Cl $Pb\,O_2$ and acetic acid the liquid distilled contains a considerable quantity of monochloro-acetic acid. The process is different when binoxide of manganese is used. No chlorine, but only carbonic acid is generated. The monochloroacetic acid is oxidized to carbonic acid and water and manganous chloride is formed.

The nomenclature of complex azo-compounds. K. Heumann, (Vol. XV, p 813.)

The author proposes to name azo-bodies in which two azo-groups are bound to the same hydrocarbon rest diazo compounds. In order to form the name the term—disazo—is appended to the name of the hydrocarbon rest carrying the two azo rests and to this the rests connected with the azo groups are attached. For example: Resorcin-disazo-benzol, benzol-disazo-benzolresorcin.

On the occurrence of Carvacrol in the essential Oil of Satureja Hortensis. E. Jahns, (Vol. XV, p 816.)

The analysis in round numbers of the oil examined:

30% carvacrol.

20% cymol.

50% of a terpen (boiling between 178–180°) besides traces of a phenol having the property of turning iron blue.

On Tetrabromchinolin and Diiodochinolin. Ad. Claus and E. Istel, (Vol. XV, p 820.)

By the action of the halogens in bisulphide of carbon solution two new products were obtained. When chinolin is dissolved in bisulphide of carbon and a solution of bromine in a considerable quantity of bisulphide is gradually added and the solution is then at once evaporated, a red-brown mass is obtained, which analysis shows to be tetrabromchinolin. By the action of sodium amalgam in alcoholic solution a portion of the bromine is taken away even in the cold and a new compound containing bromine but of a basic character is formed. This is undoubtedly not a product of addidition. A bisulphide of carbon solution of chinolin when treated with iodine. The product is one of addition corresponding to the formula $C_9 H_7 I_2 N$.

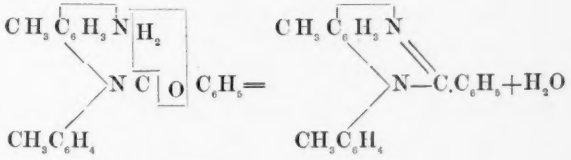
Contribution to the knowledge of Diphenylamin and Para-ditolyl-amin. Eug. Lellmann, (Vol. XV, p 825).

The benzoyl derivative of diphenylamin $C_6H_5CON\ (C_6\ H_5)_2$ according to the strength of nitrification produces one mono compound benzoyl-para-mono-nitro-diphenylamin and two dinitro compounds benzoyl-ortho-dinitro-diphenylamin and benzoyl-para-dinitro-diphenylamin. By nitrification of benzoyl-para-ditolyl-amin only orthonitro compounds are formed.

On a New Class of Amidines. E. Lellman, (Vol. XV, p 832.)

The benzol compound of para-ditolylamin was subjected to nitri-

fication and the compound formed, *i. e.* benzoyl-ortho-nitro-ditolylamin was reduced by nascent hydrogen. The benzoyl-orthoamido-para-ditolylamin by loss of water was converted into the amidin which must be termed :



para-tolyl-benzenyl-toluylen-amidin.

The Properties and the Atomic Weight of Uranium. Clemens Zimmermamn, (Vol. XV, p 847).

Prepared by reducing a mixture of potassium or sodium with chloride of uranium by heating in charcoal crucible. Uranium has the color and lustre of silver but is much harder. Striking with a hammer produces sparks. It oxidizes gradually when exposed to the air. It burns when heated on a platinum foil. It is decomposed by nitric acid. Sp. gr. is 18.7. Author gives the atomic weight equal to 240 making it the greatest of all known metals.

Contributions to the Knowledge of Anthramin. C. Liebermann and A. Ballert, (Vol. XV, p 852).

Prepared from anthral by means of ammonia in aqueous solution Heated in sealed tube with 60 times its volume of ten per cent aqueous ammonia for several hours at 250°. Anthramin can also be prepared by heating for eight hours at the return condenser with acetamid.

On Chinolin Derivatives. Td. Skraup, (Vol. XV, p 893.)

By treating m—nitro and amidotoluol, glycerin and sulphuric acid m—toluchinolin is produced. Partly controversial.

On the Preparation of the Amids of Monobasic Acids of the Fatty Series. A. W. Hofmann, (Vol. XV, p 977.)

The dry ammonia salts of the acids are subjected to a temperature of 230° under pressure for five or six hours. The tubes then contain an aqueous solution of the ammonia salt and a large quantity of the amid, which in the most advantageous case varies between 80 and 85% of the theoretical result.

On the Preparation of Mustard Oils. A. W. HOFMANN, (Vol. XV. p. 985). The double substituted sulpho-urates of the aromatic amines still serve as a starting point. By abstracting one mol. of monamin the mustard oils are produced. Diphenyl-sulpho-urate produces anilin and phenyl mustard oil.

$$CS(C_6H_5)_2H_2N_2 = C_6H_5NH_2 + C_6H_5NCS$$

The author found that concentrated solution of phosphoric acid performs the separation with ease and certainty. In all cases over 90% of the theoretical results were obtained.

On the Action of Bromine on Bisulphide of Carbon.—CARL HELL and FR. URECH, (Vol. XV. p. 987).

The result of numerous elaborate experiments is given in brief by the authors as follows: that without doubt bisulphide of carbon is not at all indifferent towards bromine, that excluding the presence of other bodies it forms a product of addition, but that in presence of water, or what is even more important, in presence of organic acids it can be completely oxidized.

On the Vapor Density of Bromine—HANS TAHN, (Vol. XV. p. 1238).

Two data only have been given before. Mitscherlich finds the vapor density equal to 5.54 and V. and C. Meyer find it 5.38 at a temperature of 99.34° C. The authors experiments are tabulated. If the vapor densities found at different temperatures are collected in a formula

$$D = a + bt,$$

then by the aid of the method of the smallest squares of the constants a and b the probable values obtained are

$$a = 5.8691 \text{ and } b = 0.00153$$

The conclusive table given is (for various temperatures) as follows:

Temperature above boiling point	Density	Deviation from the normal	Difference
40°	5.7115	3.381	0.554
60°	5.6809	2.827	0.554
80°	5.6503	2.273	0.554
100°	5.6197	1.719	0.554
120°	5.5891	1.165	0.553
140°	5.5585	0.612	0.554
160°	5.5279	0.058	

On the Expansion of Alums. W. SPRING, (Vol. XV. p. 1254). The alums expand equally between 0° and 60°. This simple result which from all appearances is due to the isomorphism of the compounds finds its confirmation in the fact that large potassium, or ammonium-alum crystals can be grown on a chrom-alum core. It is found from the results of the investigation that *Avogadro's* law can be extended to solid bodies and hence the question of determining the molecular weight of solid bodies may soon be defined from this.

Quantitative Determination of Fusel Oil in Brandy. L. MARQUARDT, (Vol. XV. p. 1370).

In 1000 grms. of a 30% brandy, prepared by mixing of 95% alcohol with water, one grm. of commercial amylic alcohol was dissolved, of this 150 grms. were shaken for 15 minutes with the same volume of water and 50cc of chloroform, and this operation repeated twice with 50cc more. The united 150cc of chloroform are united and again shaken up for 15 minutes with the same volume of water and this is repeated twice with the same quantity of water. The chloroform now containing all the fusel oil and no more alcohol was heated in a well stoppered bottle in a water bath at 85° for about 6 hours together with a solution of 5 grms. of bichromate of potash in 30 grms. of water and with 2 grms. of sulphuric acid. After completed oxidation contents of flask including the chloroform were put into a distillating flask the residue washed out with water and the whole distilled off to about 20cc. The residue was was covered with 80cc of water and distilled off, leaving about 5cc. The distillate, consisting of two layers, was mixed with barium carbonate and digested in the return condenser for 30 minutes. Chloroform was then distilled off, and the remainder evaporated down to about 5cc. The excess of barium carbonate was filtered off, washed with very little water and the filtrate evaporated to dryness. The remainder which weighed 0.396 grms. was dissolved in 100cc of water and a few drops of nitric acid. 50cc were employed for the baryta determination and 50cc for the barium chloride determination. The chlorine determination for 100cc gave 0.0638 grms. of barium chloride which is to be subtracted from 0.396 grms. of the above residue. The difference is 0.3322 grms. 0.18004 grms. of baryta were obtained from 100cc. The baryta corresponding to the chloride must be subtracted *i. e.* 0.0469 grms. There remains 0.13314 grms which is contained in 0.3322 grms. of baryta

salt and hence constitutes 40.07% of it. As barium valerianate contains 45.13% of baryta, this salt is the greater constituent of the baryta salt. For one equivalent of baryta two molecules of anylic alcohol are calculated. In the foregoing case 0.13314 grms. of baryta give 0.15315 grms. of anylic alcohol or fusel oil in 150 grms. or 102 grms. in 1000 grms. of brandy.

Artificial Piperin. L. Ruegheimer (Vol. XV. p. 1390). When the chloride of piperinic acid is treated with excess of piperidin (both being in solution in benzol fuel from water) chloride of piperidin is separated. After warming and filtering off the chloride, the benzol solution is shaken with dilute hydrochloric acid. The solution is allowed to stand and piperinic acid separates. This is filtered off, the greater part of the benzol is distilled off, ligroin (petroleum naptha) is added until a permanent precipitate is formed. The solution is then allowed to evaporate off gradually and piperin remains in form of well developed crystals.

On the Alterations of Preserved Milk. O. Loew (Vol. XV. p. 1482). A sample of milk of 400cc. was heated 40 minutes to 101° and examined eight years after. The milk sugar had disappeared and had been transformed into its hydrolytic products of division (lactose and glycose). The casein and albumen had been transformed into pepton. A portion of the pepton had undergone another change, for leucin tyrosin and ammonia were found. The tyrosin was most probably present as its anhydride.

On a New Class of Dye Stuffs. O. Fischer and Ch. Rudolph (Vol. XV. p. 1500). The name flavanilin is proposed. The product of heating together for several hours acetanilid and chloride of zinc to 250°—270°, is boiled out with hydrochloric acid, and the dye is precipitated out of the solution by salt and a small addition of acetate of soda. The color of the dye is a beautiful yellow. The ethyl compound is obtained by heating flavanilin with ethyliodide under pressure. The color is orange on silks. Flavenol is the nitrous compound. Flavolin is obtained from flavenol by mixing with zinc-dust and distilling at a dull red heat.

Abstracts from the *Journal of the Chemical Society*, London, by Arthur H. Elliott, Ph. B., F. C. S.

On Oxypropyltoluidine. By H. Forster Morley, M. A. (Vol. XLI. p. 387.)

This body is prepared by dissolving paratoluidine in propylene oxide, and distilling. It comes over between 285°—296° C. and is recrystallized from benzol. Its formnla was found to be

$$N\,(C_3\,H_7O)\,(C_7\,H_7)\,H$$

Another method of preparing this body is by allowing the above mixture to stand some days, when the new base crystallizes out, and can be re-crystallized from petroleum oil. A third method is by converting the bases into oxalates and crystallizing, the oxalate of the new base being soluble.

Oxypropyltoluidine melts at 74° C, boils at 293° C, is insoluble in water, but soluble in benzol, ether, alcohol, and petroleum. It forms an oxalate with the composition $C_{10}H_{15}NO$, $H_2C_2O_4$.

The author also describes the result of distilling oxypropyltrimethylammonium hydrate, the chief product being propylene glycol, with trimethylamine and carbonic acid; the glycol being mixed with small quantities of other bases.

On some Halogen Compounds of Acetylene. By R. T. Plimpton, Ph. D. (Vol. XLI. p. 391).

Author prepared the tetrabromide, boiling at 110°–111°C, and having a specific gravity of 2.268 at 0°C. The di-iodide was prepared by passing acetylene over iodine moistened with alcohol; it melts at 73°C; it boils at 192°C and is distilled without decomposition. The chloriodide C_2H_2HCl was prepared by passing acetylene through iodine monochloride. It boils at 119°C and the specific gravity at 0°C is 2.2298. The chlorobromide was obtained by treating the chloriodide with bromine; it boils at 81°–82°C Sp. gr. at 0°C=1.8157. Acetylene Bromiodide is prepared by passing acetylene through bromine iodide; its Sp. gr. at 0°C (solid) is 2.-750 and at 17°5C=2.6272; it boils at 150°C.

On Dihydroxybenzoic Acids and Iodo-Salicylic acids. By Alex. K. Miller, Ph.D. (Vol. XLI. p. 398).

Author prepared dihydroxybenzoic acids from catechol by heating in a sealed tube with ammonic carbonate, at 130°–140°C for 14–16 hours. Two acids were obtained, protocatechinic acid, and

an acid with the formula $C_7H_6O_4$, which differed from the former acid in its crystalline form and its reactions with ferric chloride.

The author also prepared this acid by the action of iodosalicylic acids, obtained by the direct action of iodine upon salicylic acid, and melting potash. The barium salts of the mono and di-iodosalicylic acids were prepared, but could not be separated. Finally the two acids themselves were separated by fractional crystallization. Two crops of crystals were obtained, one melting at 197° and the other at 198°C. The former is para-iodosalicylic acid and analysis gave the formula C_6H_3I (OH).COOH. This acid was heated with potash and treated with excess of hydrochloric acid. The liberated dihydroxybenzoic acid was separated by ether, and crystallized from water. Its solution gives no precipitate with lead acetate. It melts at 200°C. Heated to 215°C it gave pure quinol. Analysis gave the formula $C_6H_3(OH)_2$, COOH.

The second more soluble iodosalicylic acid obtained above by crystallization melts at 198°C. Analysis gave the formula C_6H_2I (OH).COOH. By melting this body with potash a dihydroxybenzoic acid was obtained, which differed from the above dihydroxybenzoic acid in its crystalline appearance and reactions with ferric chloride. It also gives a precipitate with lead acetate ; and on heating yields carbonic acid and catechol. It melts at 204°C. Analysis gave the formula $C_7H_6O_4$. The acid so obtained is identical with that obtained from catechol at the beginning of the paper. This completes the series of the six isomeric dihydroxybenzoic acids, and the author gives a valuable table showing the properties of each.

PROCEEDINGS OF THE AMERICAN CHEMICAL SOCIETY.

Regular Meeting, February 2, 1883.

Mr. James H. Stebbins, Jr., in chair.

The minutes of November, December and January meetings were read and approved.

The following gentlemen were unanimously elected: Messrs. Percy Neymann, J. Howard Wainwright, Max Schwartz, Vincent M. Picabia, Jas. L. Howe, Andrew Peters, F. T. Walsh and T. Lambert.

Mr. Chas. Eimer (130 E. 18th St.) was then nominated by James H. Stebbins, Jr., Wm. Rupp, and Aug. Eimer.

Remarks upon the last paper were then made by Messrs. Waller, Casamajor and Gladding.

Mr. Gladding explained at length his plan of sampling soap and determining water, as follows:

To prepare an average sample, one inch in length is taken from the middle of the bar and is thoroughly mixed with a stout spatula.

For the determination of the water, a small beaker (100 cc. capacity) is accurately weighed. Into this is then weighed a half inch in depth of pure dry quartz sand, and also a small glass rod. About 5 grams of the thoroughly mixed sample is then placed in the beaker and accurately weighed. 25 cc. of 95 per cent. alcohol are then poured into the beaker and the whole placed in a water oven. The alcohol dissolves the soap, and the contents of the beaker are stirred at intervals by means of the glass rod. As the alcohol evaporates, the soap is left in a very thin coat upon the particles of sand and the expulsion of water is very complete. The perpendicular sides of the beaker prevent any loss of alcohol from creeping.

Mr. Gladding suggested that the residue might then be treated with hot petroleum ether, the ether decanted and the treatment repeated several times and the residue again dried. The loss would be uncombined fat. The residue might then be dissolved in 95 per cent. alcohol, the solution filtered and the filtrate and residue carried through the several stages proposed by Dr. Leeds.

As he had had trouble determining the uncombined alkali by the titration recommended by Dr. Leeds, the precipitation of this by a

current of CO_2, followed by filtration and estimation of the precipitated carbonates, might be found more reliable.

The following papers were read :

1. "On the Action of Diazoanisole Chloride upon Phenoles and their Substitution Products," by Jas. H. Stebbins, Jr.
2. "On Acrolein Urea, with remarks upon Prof. Hugo Schiff's publications upon Condensed Ureas," by Dr. A. R. Leeds.
3. "Detection of Anhydrous Glucose mixed with Refined Cane Sugar," by P. Casamajor.
4. "A new Scheme of Soap Analysis, with a preliminary discussion of former methods," by Dr. A. R. Leeds.

The resignation of Mr. M. Benjamin was accepted.

The meeting then adjourned.

THOS. S. GLADDING,
Recording Secretary.

ACTION OF DIAZOANISOLE CHLORIDE UPON PHENOLES, AND THEIR SUBSTITUTION PRODUCTS.

BY JAMES H. STEBBINS, JR.

On the 29th day of Jan., 1879, Peter Griess filed a specification for the production of a red coloring matter, obtained by the action of diazoanisole chloride upon an alkaline solution of the beta sulpho acid of beta naphthole.

On Feb. 12, 1879, he filed another specification, for the production of a crimson dyestuff, formed by the action of diazoanisole chloride upon an alkaline solution of the disulpho acid of beta naphthole.

These two specifications, therefore, teach us that the diazo-ethers of phenoles can react upon phenoles, as well as the more ordinary diazo-compounds.

Since the dyestuffs produced in the above manner are but few in number, I thought it worth my while to complete, if possible, the series already so well begun.

For this purpose the following experiments were made :

Orcine-azo-benzole-di-soda salt.

12.3 grms. anisidine were dissolved in 17.9 grms. HCl. (1.20 sp. gr.), diluted with 200 cc. water.

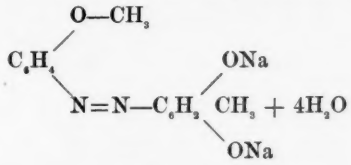
The solution thus obtained was diazotized with 6.9 grms. $NaNO_2$, in 100 cc. H_2O, and allowed to rest for about 1 hour.

It was then added, under constant stirring, to a solution composed of 12.4 grms. orcine, 200 cc. water; 8 grms. NaOH, and 10 cc. NH_4OH and A q.

The orange colored precipitate thus formed was collected on a filter, washed repeatedly with cold water, to remove all NaCl, and finally dissolved in boiling water.

The solution on cooling deposits the soda salt, in the shape of little yellow-brown needles, having in reflected light a beetle-green color.

This body probably has the following formula:

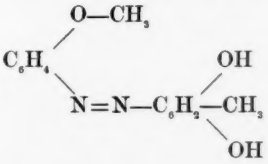


I say probably, because the figures derived from several analyses do not agree with one another, or with theory.

The above substance is insoluble in cold, and sparingly soluble in boiling water, from which it crystallizes with four molecules of water of crystallization.

It is readily soluble in alcohol, but cannot be obtained therefrom in a crystalline state.

Orcine-azo-anisole.



This substance was obtained from the soda salt, by dissolving the latter in H_2O, and adding strong HCl in excess.

A heavy brick red precipitate is thus formed, which when examined under the microscope, is found to be composed of very minute, hair fine orange-colored needles.

It was collected on a filter, washed with boiling water, till free from all HCl, and dried in the air bath at 120° C.

A combustion of the substance thus prepared, gave the following figures :

Found.

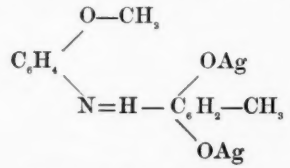
Carbon.....65.95 per cent.
Hydrogen ..... 6.16 "

Theory.

Carbon.....65.11. "
Hydrogen .....52.4 "

When heated on platinum foil, it swells up, giving off yellow fumes, and leaving as residue a large amount of porous carbon.

Orcine-azo-anisole di silver salt.



This body was obtained from a hot aqueous solution of the soda salt, by adding $AgNO_3$ in excess. The blood red precipitate thus formed, was collected on a filter, and washed with boiling water, till free from all traces of $AgNO_3$, and finally dried at 110°C. It is insoluble in water, and but sparingly soluble in alcohol.

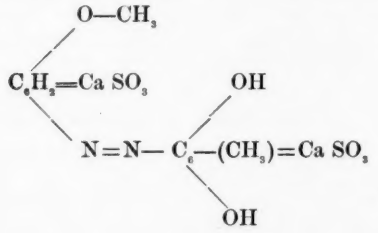
Owing to its properties of not crystallizing, it was impossible of obtaining a fair sample for analysis, and therefore the figures obtained are somewhat too high.

0.1047 grms. silver salt gave 0.0530 grs. Ag.
Equivalent to Ag. 50.62%

Theory.

Silver.....45.76%

Orcine-azo-anisole-disulphonate of lime.



This interesting substance was obtained by heating 1 pt. of orcine-azo-anisole with 3 pts. of very strong fuming sulphuric acid, on the water bath for about 1 hour.

The beetle green melt thus obtained, was powdered into hot water, and neutralized with carbonate of lime. The $CaSO_4$ was collected on a filter, and the filtrate containing the lime salt, evaporated to dryness.

This salt is a yellow-brown, slightly crystalline powder, and is readily soluble in water with an orange color.

A calcium estimation gave the following figures :

Found.

Calcium.....15.29%

Theory.

Calcium..... 16.06%

Furthermore a sulphur estimation gave :

Sulphur..... 13,71%

Theory.

Sulphur..... 12.85%

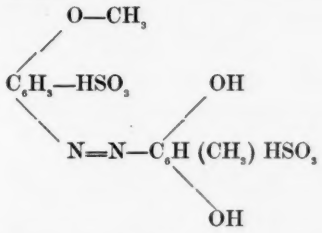
Reduction Products.

The above orcine-azo-anisole disulphonate of lime was dissolved in water, and boiled with an excess of stannous chloride, until the solution became nearly colorless.

The tin was precipitated with caustic soda, and collected on a filter. The filtrate was then shaken up with ether, hoping thereby to take up the reduction products.

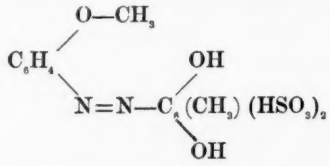
After the ether had been evaporated, a small amount of a white crystalline body remained behind, but no oil drops of anisidine were to be found.

It may therefore be surmised that the original sulpho acid, has the following constitution :

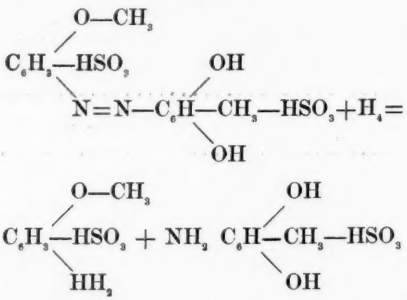


In other words, that the sulpho groups are evenly distributed

among the two benzole nuclei, instead of their both being contained in the benzole nucleus pertaining to the orcine ; thus :



This would therefore account for the absence of anisidine among the reduction products. As a compound of the foregoing constitution, would probably split up on reduction, into anisidine sulpho-acid, and amido orcine sulpho-acid ; thus :



As both there substances are sulpho-acids, they would probably not be precipitated by caustic soda, but, would combine with the latter to form soda salts.

ACROLEIN-UREA, WITH REMARKS UPON MR. HUGO SCHIFF'S PUBLICATIONS UPON CONDENSED UREAS.

By Albert R. Leeds.

I find that Mr. Hugo Schiff* attributes my statement (this Journal, iv. p. 58) that the body which he described as Acryldiureid.

$$\left.\begin{matrix} CO.N_2H_3 \\ CO.N_2H_3 \end{matrix}\right\} C_3H_4$$

(Ann. Chem. Pharm. 151, 203), is in reality Acrolein-urea, $CO.(NH)_2\,C_3\,H_4$, to the fact that I had not consulted his original

* Ber. dentsch. Chem. Gesell. xv. 1393.

memoir, but an incorrect extract therefrom. I wish to state expressly that this was not the case, and that my own experiments were conducted with constant reference to Mr. Schiff's original memoir in the Ann. Chem. Pharm. loc. cit., and that I did not isolate the compound containing the residue from 2 molecules of urea, but only the compound with the residue from one molecule or $CO.(NH)_2 C_3 H_4$. Furthermore, I wish to state that the non-crystalline, white body which I obtained by the purification of the precipitate which ensues when acrolein is added to an alcoholic solution of urea, and found to be $CO.(NH)_2 C_3 H_4$, is the same compound as is obtained when an aqueous solution of urea is treated with acrolein, in the manner described by Mr. Schiff, but which he did not purify adequately, and to which he consequently gave the erroneous formula of an Acryldiureid.

In his criticism upon my article, Mr. Schiff says that he analyzed this compound which he obtained with an aqueous solution of urea, and that it contained 38.3 per cent. carbon, the right percentage for Acryldiureid. But in the memoir to which Mr. Schiff has referred me no such analysis is given, and if this analysis is not contained in that memoir, I desire to be referred to some article published before this reply of Mr. Schiff, in which it can be found.

I have stated that I was able to isolate, and that with much difficulty, but one compound in a state of purity, and for that reason I analyzed only this one compound, finding in it Carbon 49.01 per cent. (accidentally misprinted in the Berichte 40.01 per cent.) and Hydrogen 6.30 per cent. There is undoubtedly a resinous, oily by-product, to whose presence the difficulty of obtaining the pure compound is due. But Mr. Schiff has analyzed the various mixtures obtained after more or less partial purification, and deemed that he was entitled on the strength of such analyses so conclude in the first place that he had *isolated* Acryldiureid, and that another body, which he did not isolate but obtained as a white porcelain-like substance intimately mixed with acrolein was Diacryltriureid, 42.2 per cent. Carbon and 6.3 per cent. Hydrogen. The figures which he obtained by analysis of this mixture, and which are the only figures given in the memoir he has referred me to, varied between C. 44–47 per cent. and H. 6.9–7.1 per cent.

The method which Mr. Schiff employed to obtain his Diacryltriureid, by treating pulverized urea directly with acrolein, no solvents being employed, was one which required more than usual care and perseverance in the consequent treatment of the product with

solvents in order to separate the bodies thus formed in a state of purity. No such precautions are stated to have been used. On the contrary in his reply to my article, Mr. Schiff has persisted in his plan of making analyses of mixtures, and from his results, he has inferred the presence in these mixtures of no less than three compounds, the composition of anyone of which differs widely from the figures actually obtained.

I think the majority of chemists would find it difficult to believe that Mr. Schiff has endeavored to support the erroneous conclusions arrived at in his original memoir in the Ann. Chem. Pharm., by methods even more inexact and reprehensible, were they not to read his own statements contained in the Berichte XV, 1395. He states there that a portion of the product obtained by the direct action of Acrolein upon Urea, after keeping for 14 years, had undergone a peculiar alteration. About two-thirds had become of a strong canary color, "und man sieht deutlich, wie die Stücken von einer weissen Masse durchzogen sind, so dass die gelben Stücken ofters centrale weisse Stellen zeigen und hierdurch oxalartiag und fast perlmuttuähnlich aussehen. Die Antheile von Krystallinische Aussehen haben dieses Aussehen sowie ihre weisse Farbe bewahrt, aber man Kann jetzt auch bei diesen Stückchen, bei Vergrosserung, um so besser sehen, dass noch gelbe und porcellanartig weisse Substanz innigst beigemengt ist. Leider war gerade diese letztere, weniger cohärente Masse grössten theils zu grobern Pulver zerfallen."

And yet the constituents of a mixture like this, which it would have required great care to have properly separated by means of appropriate solvents, Mr. Schiff attempted to separate by mechanical means, and to pick them out by the aid of a magnifier.

He thus obtained (1) "Gelbe amorphe Substanz mit wenig wiesser porcellanartiger Substanz durchzogen," and with the composition C. 46.81 p ct., H. 7.09 p ct; (2) "Weisse, auscheineud Krystallinische Substanz, noch etwas amorphe weisse und gelbe Verbindung einschliessend," with the composition, C. 45. 15 p ct., H. 6.54 p ct. From these anylyses by a very complicated process of inductive logic, Mr. Schiff concludes that his mixture analyzed consisted of no less than three different compounds, viz :—Acrylureid C. 49 p ct., and H. 6.1 p ct ; Acryldiureid C. 38 p ct., and H. 6.3 p ct., together with Acrylharz C. 60.61 p ct., and H 7–7. 5 p ct.

When we remember that in his original memoir Mr. Schiff stated that the mixture above analyzed contained Diacryltriureid C. 42.2

p ct., and H. 6.3 p ct., and now are told that by a process of logic he infers from analyses performed upon the same material, but much altered after standing 14 years, he has shown that the mixture was really Acrylureid, Acryldiureid and Acrylharz, we are in a position to know how much reliance should be placed either upon the work as first performed, or as afterwards corrected. Mr. Schiff has never isolated Acrylureid, but accepts my own statement as proof of its existence; he has never isolated Acryldiureid, but on the contrary has called Acryldiureid what was in in fact impure Acrylureid, and yet in this final statement he affirms that both these bodies exist in a certain mixture together with an unknown quantity of a resin.

ŒNANTHUREIDE, BENZUREIDE, ŒNANTHO-BENZUREIDE, ETC.

But the foregoing are the smallest among the many marvellous results which Mr. Schiff has arrived at, by applying a great deal of logic to the analyses of complex mixtures. In the original memoir to which he has referred me, he states that he obtained by treating a strong alcoholic solution of Urea with alcohol, Œnanthodiureïd, $C_9 H_{20} N_4 O_2$, (analysis not given) as a crystalline body melting at 166° to a yellow oil. Further on that he obtained by treatment of Œnanthol with crystals of Urea, Diönanthotriureïd, $C_{17} H_{36} N_6 O_3$ (analysis not given), as a crystalline body melting at 162° to a yellow oil. When these two Œnanthureide are treated again with small quanties of Œnanthol, water is formed and the ureide change into "zähe hornige" masses. After cooling these masses are pulverized as far as possible, and extracted with ether. In this manner condensed Ureas are obtained, Trioenanthotetrureid, $C_{25} H_{52} N_8 O_4$ and Pentoenanthohexureid, $C_{41} H_{84} N_{12} O_6$. The former a yellow powder melting about 155°, the latter is a heavy mass which appears to melt at 150°.

When the raw product obtained in the preparation of this hexureid is treated with alcoholic ether and the extract evaporated, there remains behind an amorphous residue. Acetone takes out some œnanthol and leaves a gelatinuous mass which dissolves in alcohol. The solution at a certain degree of condensation solidifies to a glue like substance, which dries to a brittle varnish. This body consists of *twelve* molecules of urea united by the residues from *eleven* molecules of œnanthol, or Dodekoenanathondekaureid:

$$C_{89} H_{180} N_{24} O_{12} = 12\ CH_4 N_2 O + 11\ C_7 H_{14} O - 11\ H_2 O$$

	Calculated.	*Found.*
Carbon	60.1	60.5
Hydrogen	10.1	10.6

But why, according to Schiff's methods of reasoning, should not this glue-like substance solidifying to a varnish be inferred from the analysis to consist of sixteen molecules of urea united with the residues from 15 molecules of œnanthol, this supposition agreeing better with his own results!

$$C_{121}\,H_{244}\,N_{32}\,O_{16} = 16\,C\,H_4\,N_2\,O + 15\,Cy\,H_{14}\,O - 15\,H_2\,O$$

	Calculated.	*Found.*
Carbon	60.5	60.5
Hydrogen	10.2	10.9

It is an extremely fortunate circumstance that, as Mr. Schiff remarks, the ureas more condensed than the hexureid are so very similar in their constitution and so difficult of purification, that he was unable to establish their formulæ "*with certainty.*"

For he truly says, that these substances are very remarkable in regard to their contained nitrogen, since no continuations have ever yet been artificially produced with so large a number of nitrogen atoms. If more of such compounds had been produced the complex nitrogenous substances of animal origin would have appeared simple in comparison.

It is needless to discuss the Benzo-diönanthotetrureid $C_{25}\,H_{44}\,N_8\,O_4$ and the Benzo-tetrönanthohexureid $C_{41}\,H_{76}\,N_{12}\,O_6 = 6\,CH_4\,N_2O + 4\,C_7\,H_{14}O + C_7\,H_6 - 5\,H_2O$. Analyses are given which agree sufficiently well with this formula, but they likewise agree with other formulæ which might quite as reasonably be assigned, and it is a dangerous precedent to assign value to analyses of a body stated to be like *dried fibrine* (!) and of whose purity there is no proof whatsoever.

All of the foregoing, and the further work of Mr. H. Schiff upon Anisureïde, Salicylureïde, Æthylsalicylureïde, Æthylidenharnstoff, etc., etc., must be repeated, and his results verified, before his views upon the constitution of these condensed ureas can be regarded as worthy of acceptation.

DETECTION OF ANHYDROUS GLUCOSE, MIXED WITH REFINED CANE SUGAR.

By P. Casamajor.

I lately received from Chicago a sample of sugar, suspected of being adulterated. The appearance of this sugar, and the sensation to the touch, were decidedly in favor of the supposition that starch sugar had been mixed with it. The sensation to the touch is very characteristic of such mixtures. The person who sent the sugar described this sensation by saying that "it felt like ground cocoanut."

Upon applying to the suspected sugar several tests, which had been found efficacious in detecting common hydrated starch glucose, the following results were obtained :

A test which was described before this Society at its meeting of March, 1880,* consists in stirring a suspected sugar with a small quantity of water. If any ordinary commercial starch glucose is present, this will appear as chalky white specks, which are distinctly seen in the translucent mass of wet sugar. This test is worthless with crystallized anhydrous glucose, as the crystals of this substance have, when mixed with water into a paste, the same translucency as crystals of cane sugar.

I also applied to the suspected sugar, the test which consists in treating a sample of sugar with a saturated solution of starch glucose in methylic alcohol of density equal to 50° of Gay Lussac's alcohometer.† In the present instance, the saturated glucose solution which I used was made from anhydrous dextrose. By washing the suspected sugar with this solution, a small crystalline residue was obtained, which could not represent the total glucose present, as there was only 5 p. c., a quantity too small to pay for the trouble of mixing it with refined sugar.

The crystalline residue, placed under a microscope, showed the elongated square prisms, characteristic of anhydrous glucose, a form which cannot be mistaken for crystals of cane sugar, and still less for the thin plates of hydrated glucose.

Before proceeding with accounts of further tests, I must here withdraw a suggestion made by me before this Society in November, 1880,‡ to the effect that starch glucose, mixed with refined

* "Journal of the American Chemical Society," Vol. II., p. 111.

† *Ibid*, p. 428.

‡ *Ibid*, p. 429.

cane sugar, could very likely be determined quantitatively by washing the suspected sugar with a saturated solution of starch glucose in methylic alcohol, and then weighing the residue. I suggested this process as one that might succeed, but one which I had not had occasion to try. The results which I have since obtained with this process show that the residue is much less than the quantity of starch sugar originally present. This is undoubtedly owing to this, that after dissolving cane sugar, the methylic solution acquires the property of dissolving additional quantities of starch sugar.

The sample of suspected sugar was also tested by the optical saccharometer. The direct test was 93.7 p. c. The solution was inverted, giving as a result 74.5 p. c. of pure sugar. This result clearly showed adulteration by a dextro-rotary substance. It does not, however, represent the actual quantity of cane sugar present, as I will show, by examining the influence of anhydrous glucose in a case of this kind.

To study this influence, I took 26.048 grammes of anhydrous glucose, which were dissolved in sufficient water to give 100 cc. of solution. A portion of this being placed immediately in the tube of the saccharometer, gave a deviation of 115.4 to the right. After standing in the tube for twenty minutes, the deviation fell to 95.7; after two hours, the deviation was 82.5. It was then allowed to stay over night in the tube, and, fourteen hours after, the deviation had fallen to 78.8, which did not vary afterwards on standing for several hours. The solution was then heated to 68° C. with 10 per cent. of its volume of hydro-chloric acid, the operation taking about fifteen minutes. This, after being neutralized with carbonate of soda gave a deviation to the right still equal to 78.8. There had then been no change by treating with hydro-chloric acid, which shows that the presence of dextrose is no bar to obtaining correct results by inversion, provided both observations, before and after inversion, are made after the deviating power of dextrose has reached a state of rest.

Returning to the test of the suspected sugar by the optical saccharometer, we have seen that the deviation to the right was at first 93.7 per cent. After standing in the tube fifteen minutes, the deviation fell to 90.2. We have seen that the result obtained by inverting, after the first reading, was 74.5. This result is evidently too high as the dextro rotary power of the dextrose present had diminished in the interval between the two observations.

Another sample of adulterated sugar was placed in the sacchar-

ometer as quickly as was practicable, after dissolving it in water. The indication was 100.4 per cent. As this sugar had all the appearance of a low sugar, this indication was sufficient to show that it was adulterated. This solution was kept in the tube for further examination. Fifteen minutes afterwards, the deviation had fallen to 94.3 per cent. Half an hour from the first observation, the reading was 91.6 ; one hour after, 90.2 ; two hours after, 89.9 ; three hours after, 89.7 ; five hours after, 89.3. After this there was no further variation. After inversion the indication was 72.7 per cent., which was considered as the correct percentage of pure sugar.

The optical saccharometer may then be considered as sufficient to determine if starch glucose is present in a sugar, by observing the deviation immediately after getting the solution ready for the saccharometer, and repeating the observation at sufficiently wide intervals of time. If dextrose is present in notable quantities, the deviation will decrease in a marked manner. Although the proof obtained in this way is satisfactory, it can only be applied by the very few persons who have saccharometers. To combat adulteration the best processes are those which can be easily applied by dealers and consumers, who are unprovided with scientific appliances.

The following process can be applied by using such means as are at the command of everybody. It is applicable to the detection of adulteration with either anhydrous or hydrated glucose :

Take two beaker glasses or two tea-cups. In one put a quantity of the suspected sugar, and in the other put about the same quantity of a sugar known to be refined sugar, free from adulteration.

Add, cautiously and gradually, a quantity of water to each sugar sufficient to make each equally and decidedly moist, and stir the sugar to mix it well and get it uniformly wet. Then place both cups in hot water. Any temperature between 50° and 100° C. will do. In about ten minutes the pure sugar will appear more moist than when cold, while the other sugar, if it contains a sufficient amount of starch glucose, will have sunk into a pasty, sticky mass, analogous to the *fill mass* of sugar refiners.

The application of heat is not indispensable, as a difference may be obtained by allowing the two sugars to stand several hours after being moistened, but, with heat, the effect is immediate, and is much more marked.

If the two samples of sugar are allowed to stand in the cups after they have cooled down, the pure sugar will look dryer on becoming

cold, while the adulterated sugar will continue in the state of a pasty, sticky mass.

This test is founded on the property possessed by cane sugar to form viscous, uncrystallizable compounds when mixed with many organic or inorganic substances, among which are anhydrous and hydrated dextrose. An example of compounds of this kind is *molasses*, obtained as as a residuum in sugar manufacture.

As long as a mixture of cane sugar and starch glucose is sufficiently dry, it may look fair enough, as the elements which form molasses are kept from combining by want of water. The sugar adulterator is well aware of this, and he is careful to dry his sugar before mixing with glucose. Indeed, one characteristic of adulterated sugars is that they are always dryer than refined sugars of the same grade, which are known as *coffee sugars*, and are always sold moist.

As soon as sufficient water is added to an adulterated sugar, and moderate heat is applied, enough viscous syrup is formed to make the sugar sink into a paste, which remains permanently soft.

Useful indications may be obtained as to adulteration by starch glucose, by means of Fehling's solution. An ordinary refined coffee sugar will rarely show more than 5 percent. of glucose, while a sugar adulterated with the usual dose of starch glucose, will show about 20 per cent. of glucose.

ANALYSIS OF SOAP.

By Dr. Albert R. Leeds.

In the analysis of soap it is necessary to determine :—

(1) Water.

(2) Uncombined fat.

(3) Soap consisting of (3a.) combined Fatty Acids, estimated as Fatty Anhydrides, and (3b.) Combined Alkali, usually Soda (Na_2O).

(4) Uncombined Alkali.

(5) Glycerine.

(6) Resin.

(7) Sodic Carbonate.

(8) Sodic Chloride.

(9) Sodic Sulphate.

(10) Sodic Silicate—consisting of (10a) Soda combined in Silicate, and (10b.) Silica.

(11) Starch.

(12) Insolible Residue, or mineral impurities, such as talc, clay, ochre, sand, etc.

(1) *Water.*—Weigh out about 5 grms. in very fine, small shavings upon a dried, weighed, plaited filter. Dry at 110° until weight is constant. The loss is water.

(2) *Uncombined fat.*—Transfer the filter containing the dried soap to the funnel connected with the return cooler as in the determination of the albuminoids in milk, and connect with the funnel a small tared flask containing 50cc. petroleum ether. After complete extraction distil off the ether, and the residue in the flask dried at 110° will be the uncombined fat.

(3) Soap, (4) Free Alkali, (5) Glycerine. Allowing the funnel with the soap freed from moisture and from fat to remain on the return cooler, attach to it a flask containing about 75cc of 95% alcohol and extract. To the alcoholic solution add a few drops of phenol-phthalëin, if free alkali be present neutralize with normal sulphuric acid and calculate the amount of uncombined soda.

After neutralization add a large excess of water and boil off the alcohol. To the aqueous solution, add a large excess of normal sulphuric acid. Boil, cool and decant through a small filter, wash with hot water and decant after cooling through the filter until litmus paper is no longer reddened by the washings. The filtrate consists of the combined soda and glycerine; the residue of fatty acids and resin. Neutralize the filtrate with normal soda solution and calculate the amount of combined soda as Na_2O. Evaporate to dryness and extract the glycerine with absolute alcohol. Transfer the alcoholic solution to a tared flask, distil off the alcohol, dry at 100° and weigh the residue as glycerine.

Fatty acids and Resin. Dissolve the small amount of the fatty acids and resin that may be on the filter, through which the decantation was effected, with a little petroleum ether, add the solution to the larger bulk in the beaker, evaporate off the ether, dry at 110° and weigh the combined fatty acids and multiply this result after subtracting the amount of resin by 0.97, and the product is the Fatty Anhydrides and resin.

(6) Resin. The resin was separated from the fatty acids according to the method proposed by Gladding (American Chemical *Journal*, Vol. III, p. 416.)

The original article by Gladding, reads as follows :—

THE QUANTITATIVE SEPARATION OF ROSIN FROM FATS.

"About 0.5 gram of the fat acids containing the rosin is introduced into a small flask. Twenty cubic centimetres of 95 per cent. alcohol are added, and the flask rotated till the fat acids and the rosin are dissolved. A drop of phenol phthalëin is now added, and then a saturated solution of caustic potash in alcohol drop by drop, with thorough agitation after the addition of each drop, until the deep red color characteristic of alkalinity is obtained. One or two additional drops are now added, and the flask placed on a water-oven and kept at the temperature of boiling alcohol for ten minutes to ensure the saponification of the last portions of fat. The flask should be loosely corked. It is now cooled and the contents washed into a graduated 100 cc. cylinder by means of concentrated ether. The cylinder is filled with the ether exactly to the 100 cc. mark ; then corked, best by a common cork twisted tightly in, and the contents mixed by a moment's shaking. About one gram of C. P. *neutral* silver nitrate is now rubbed to an impalpable powder in a a small mortar and then introduced into the cylinder. The latter is vigorously shaken for ten or fifteen minutes until the flocculent precipitate of silver stearate and oleate collects in the same manner as silver chloride upon shaking, and settles clear. Fifty to seventy cc. of the supernatant liquid are now syphoned off by means of a slender syphon, previously filled with ether, into a second 100 cc. cylinder, passing the liquid through a small filter paper if it is not perfectly clear. A small quantity of pulverized silver nitrate is shaken up with this to make certain that all the oleate and stearate are precipitated. If no flocculent precipitate appears this is the case. Twenty cc. of a mixture of hydrochloric acid and water, one-third the former and two-thirds the latter, are now added, and the cylinder vigorously shaken until the decomposition of all the silver salt present is complete. After the silver chloride has settled, an aliquot portion of the supernatant ether solution is syphoned off into a platinum dish and evaporated on the top of a water-oven to dryness. The residue is rosin containing a small amount of oleic acid, which can be accurately allowed for."

The following experiment gives the allowance to be made :

"*Exp.* II. One-half a gram of pure fat acid was treated in the above way. Eighty cc. shaken with HCl and evaporated gave

0.0188 gram of residue; 10 cc. contain therefore 0.00235 gram of oleic acid. This very small and accurate correction of 0.00235 gram for every 10 cc. of liquid shaken up with HCl was applied in the subsequent experiments."

The manner of calculating the allowance may be most clearly shown by another experiment:

"*Exp.* IV. One-half a gram of the fat acids from linseed oil was add to 0.050 gram of rosin and treated as the above.

"Seventy cc. shaken with HCl gave 0.0517 gram of residue. Subtracting the allowance for 70 cc., namely, 0.0164 gram, leaves 0.0353 gram of 0.0504 gram of rosin on the whole quantity taken instead of 0.050 gram taken."

About 0.5 grm. of the mixture of the fatty acids and resin are dissolved in twenty cc. of strong alcohol and, with phenol-phthalëin as an indicator, soda is run in to a slight supersaturation. The alcoholic solution, after boiling for ten minutes to ensure complete saponification, is mixed with ether in a graduated cylinder till the volume is 100 cc. To the alcoholic and ethereal solution 1 grm. of very finely powdered Ag. NO_3 is added and the contents of the cylinder are shaken thoroughly for ten or fifteen minutes. After the precipitate has settled, 50 cc. are measured off and if necessary filtered into a second graduated cylinder. A little more Ag. NO_3 is added to see if the precipitation is complete and then 20 cc. of dilute hydrochloric (1:2) to decompose the silver resinate. An aliquot part of the ethereal solution in the cylinder is evaporated in a tared dish and weighed as resin, deducting a small correction (for 10 cc. 0.00235 grm.) for oleic acid. The amount of resin substracted from the combined weight of fatty acids and resins, as found before, gives the fatty acids. (7) Sodic carbonate; (8) Sodic chloride; (9) Sodic sulphate; (10) Sodic silicate; (11) starch; (12) insoluble residue. The filter in the funnel connected with the return cooler, after treatment with alcohol contains the mineral constituents of the soap. The contents of the filter are washed with cold water till the washings amount to 60 cc. The filter is then dried and weighed. The weight gives the insoluble residue and starch.

The starch is converted into $C_6H_{12}O_6$ with dilute acid and titrated with Fehling's solution. The weight of starch found substracted from the total weight of insoluble residue and starch gives the insoluble mineral constituents.

The aqueous solution of 60 cc. just mentioned, is divided into

four equal parts, in one of which is determined the carbonate of soda titration and in the other parts, the chloride, the sulphate and the silicate respectively, by any convenient method.

My thanks are due to my assistant, Dr. Edgar Everhart, for his assistance in working out the details of this scheme.

SCHEME FOR SOAP ANALYSIS.

Weigh out 5 grms. Dry at 110°. Loss corresponds to water. Treat with petroleum ether.

Extract is uncombined fat. Dry at 110° and weigh.

Residue = Soap and Mineral constituents. Treat with alcohol.

Extract = Soap (Fatty anhydride, resin and combined alkali), Glycerine and Free alkali. Add two or three drops of phenol-phtalëin. If necessary, titrate with normal H_2SO_4.

H_2SO_4 used corresponds to free alkali. Calculate as NaHO

Add a large excess of water and boil off the alcohol. Decompose with excess of normal H_2SO_4. Boil, filter and wash.

Filtrate. Combined soda and glycerine. Titrate with normal soda solution.

H_2SO_4 used corresponds to combined soda in soap. Calculate as Na_2O.

After titration evaporate to dryness on the water bath. Treat with absolute alcohol. Evaporate the alcoholic solution to dryness in a tared dish and weigh as glycerine.

Residue—Fatty acids and Resin. Dry at 110° and weigh. Dissolve an aliquot part in 20 cc. strong alcohol, and using phenol-phtalëin as an indicator, saponify with soda in slight excess. Boil, cool and add either to 100 cc. Decompose with $AgNO_3$ by adding in fine powder, and shake well for 10 minutes. Allow to settle.

Precipitate. Stearate palmitate and oleate of silver.

Solution—Resinate of silver. Filter 50 cc. from the total 100 cc. Decompose with 20 cc. HCl (1:2) Allow the AgCl to settle and evaporate an aliquot part of the ethereal solution in a tared dish. Dry at 110° and weigh. After applying correction for oleic acid the weight corresponds to the resin. This weight subtracted from the combined weight of fatty acids and resins, gives the fatty acids.

Residue.—Na_2CO_3, NaCl, Na_2SO_4, sodium silicate, starch and insoluble residue. Wash with 60 cc. water.

Filtrate Na_2CO_3, NaCl, Na_2SO_4, and Sodium silicate. Divide into 4 equal parts.

Na_2CO_3 Titrate with normal H_2SO_4 and calculate as Na_2CO_3.

NaCl Titrate with $AgNO_3$, or weigh as AgCl. Calculate as NaCl.

Na_2SO_4 Weigh as $BaSO_4$. Calculate to Na_2SO_4.

Sodium silicate. Decompose with HCl, and determine soda combined in Silicate and Silica.

Residue—Starch and Insoluble Residue. Dry the filter. The weight is the Starch and Insoluble Residue Starch. Convert the starch into $C_6H_{12}O_6$ Titrate with Fehling's solution. Subtract weight of starch found and difference is Insoluble Mineral constituents.

ABSTRACTS.

Abstracts from *Berichte der Deutschen Chemischen Gesellschaft*, by Percy Neymann, Ph. B.

On Synthetical Oxalic Acid. V. MERZ and W. WEITH, (Vol. XV., p. 1507). The idea was taken from the fact that formic acid can be produced from inorganic material, namely, carbonic oxide and caustic soda. Considering the large production of alkali formiates, it seemed possible that oxalic acid might be formed from these materials. Investigation was extended to the potassium and sodium salts of formic acid, also the calcium, barium and magnesium salts. The formiates were subjected to the heat of baths of various substances. In the diphenylamin bath (310°) the sodium formiate is scarcely decomposed. At 360° (mercury bath) it is mostly converted into carbonate, and at 440° (sulphur bath) it is mainly converted into the oxalate. The potassium salt behaves in a similar manner. The other salts gave no oxalate even at 440°.

Vanadintrichlorid from Vanadintrisulphide. W. HALLERSTADT, (Vol. XV., p. 1619.) The sulphide is heated (in a drawn out piece of combustion tubing, the small end of which is connected with a distilling flask) in a current of chlorine at a moderate temperature. The liquid produced is distilled. The residue, which consists of Vanadintrichlorid, is treated in a steam of carbonic acid at 150° C.

An Ammoniacal-alkaline Silver Solution as Reagent for Aldehyde. B. TOLLENS, (Vol. XV., p. 1635.) The author finds a solution of the following composition to be the best :

Three grms. of nitrate of silver are dissolved in 30 grms. of ammonia of 0.923 sp. gr.

Three grms. of caustic soda are dissolved in 30 grms. of water. The two solutions are mixed and used after a few days. The reagent must be kept in a cool, dark place.

Quantitative Estimation of Fusil Oil in Brandy. L. MARQUARDT, (Vol. XV. p. 1661.) Continued from Vol. XV. p. 1370. Author adds that ether cannot be used in place of chloroform. Common chloral chloroform, such as is used for surgical purposes is not pure enough. Even that known as pure chloroform should be subjected to one or two oxidations with bichromate of

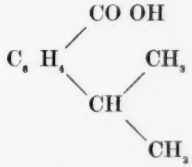
potassa and sulphuric acid. The alcohol must also be purified. The author appends a qualitative analysis.

On Soluble Alizarin Blue. H. Brunck and C. Graehl, (Vol. XV. p. 1783.) The dye is called alizarin blue S. alizarin blue as it occurs in commerce, in a paste of 10—12 % of dry constituents is mixed with a 25—30 % solution of sodium bisulphite. When the solution is filtered, unaltered alizarin blue remains on the filter which can be treated again. The filtrate contains the new compound which can be obtained in cystalline form.

Preparation of Peroxide of Lead. A. Fehrmann, (Vol. XV. p. 1882.) It is best and most cheaply prepared by treating a solution of chloride of lead (50—60° C.) with chloride of lime until a filtered sample shows no more brown color. It is then filtered off with exclusion of air.

The Synthesis of Cuminic Acid. Rich. Meyer and Erwin Mueller, (Vol. XV. p. 1903.) The cumol was prepared according to Gustavson's method, by the action of secondary propylbromid on benzol in the presence of $Al_2 Br_6$.

The synthetical cumol was transformed into the bromine compound in the usual manner, and the acid produced in the same manner as in the first experiments (Vol. XV. p. 496.698, Ber-d-d-chem Ges.) The melting point was found to be 116°—117° C., and the formula (1.4):



On the Reduction of Molybdenum Compounds. Otto Freiherr von der Pfordten, (Vol. XV. p. 1925.) The volumetric method is important. Titration is performed in the usual manner, whereby the suboxide is transformed into the sesquioxide which latter is used for calculations. The salt is dissolved in a little water, to which are added 60 cc of a 27 per cent. hydrochloric acid and 8—10 grms. of zinc in bars, the iron in which has been determined by titration. When the solution has assumed a yellow color, and before all the zinc is consumed the flask is cooled, and contents thrown into a porcelain dish containing water, dil. sulphuric acid and manganous sulphate solution of the concentration

given by *Zimmermann*. From a pipette more permanganate solution is added and titred to pink color as usual. The results are accurate

1 cc K Mn O_4=0.000752185 Oxygen
1 cc K Mn O_4=0.00451311 Mo O_3

Method for determination of phosphoric acid. Otto, Freiherr v. d. Pfordten. (Vol. XV., p. 1929).

The method is based upon the estimation of molybdic acid. The composition of the yellow precipitate is assumed to be that given by Finkener and Pemberton. One mol. $P_2 O_5$ to 24 mol. Mo 0_3.

The method is applicable in all cases in which the separation of the phosphoric acid with molybdate of ammonium can take place.

On some chinolin derivatives. O. Rhoussopoulos. (Vol. XV., p. 2008). Chinolin and Ethylmonochlor-acetate give rise to a chloride.

$$C_9 H_7 N + CH_2 Cl CO_2 C_2 H_5 = C_9 H_7 NCH_2 CO_2 C_2 H_5 Cl.$$

It may be termed the chlorohydrate of the chinolin-glycocoll-ethylether.

The Betaïn of Chinolin $C_{11} H_9 NO_2$, $H_2 O$ can be obtained from the chlorohydrate by treatment with oxide of silver.

On the application of diphenylamin and anilin in qualitative analysis. Conrad Laar. (Vol. XV., p. 2086).

On azylines, a homologous series of bases containing nitrogen. E. Lippmann and F. Tleisner. (Vol. XV., p. 2136).

Nitrous oxide acts on amines and amido acids, eliminating nitrogen and forming a hydroxyl derivative. When nitrous oxide is passed into an alcoholic solution of dimethyl anilin, the solution is colored deep red, carbonic acid is evolved and crystals are formed. The reaction takes place according to the formula :

$$2 C_8 H_{11} N + 2 NO = 2 H_2 O + C_{16} H_{18} N_4.$$

Azylins are compounds containing nitrogen which are obtained by the action of nitrous oxide on bases into which the =N-N= has entered the benzol ring with four free bonds while azo compounds are those which are characterised by the bivalent group —N=N—.

The compounds are insoluble in water but soluble with beautiful red color in hydrochloric acid and with a beautiful green color in acetic acid. The melting points increase with the decrease in molecular weight.

Contributions to the history of conydrin. A. W. Hofmann. (Vol. XV., p. 2313). The author determines the formula of conydrin to be the same as that given by *Wertheim* $C_8 H_{17} NO$.

On the behavior of the alkali phosphates towards some indicators. G. Tobias. (Vol. XV., p. 2452). By the action of phosphoric acid on alkalies the changes of color of the indicators are not as decided as with other acids. Experiments with litmus, phenolphtalëin and aqueous solution of cochineal on different solutions (1) a dilute aqueous solution of pure commercial phosphoric acid was taken and allowed to stand for some time, it then was boiled to remove all modifications of phosphoric acid, except ortho–100 cc contained 4.095 $H_3 PO_4$; (2) a solution of double this strength, 100 cc = 8.190 $H_3 PO_4$; (3) potassa, freed from carbonic acid and from $K_2 SO_4$ by means of $Ba(OH)_2$, 100 cc = 4.096 KOH; (4) soda solution, 100 cc = 2.349 NaOH; (5) ammonia, freed from carbonic acid, 100 cc = 1.950 NH_3; (6) di-sodic phosphate, 100 cc = 3.4165 $Na_2 HPO_4$.

In no case were the results satisfactory, the indicators mentioned above should not be used for the titration of phosphoric acid.

Lecture experiments with Zinc dust and Sulphur. H. Schwarz. (Vol. XV., p. 2505). The old experiment employed for demonstrating chemical union by heating sulphur and copper or iron filings is well known. The demonstration can be shown much more brilliantly by heating a mixture of zinc dust and sulphur. When mixed in the proportion of atomic weights, 65 parts of zinc and 32 parts of sulphur in a mortar (but with great care) the mixture can be easily ignited by a match and will burn like gunpowder. The mixture can be partly exploded by a smart blow of the hammer.

When the vapor of bisulphide of carbon is brought in contact with heated zinc dust, the zinc dust immediately begins to glow; sulphide of zinc is formed and carbon separates.

Carbon in statu nascendi easily unites with nascent hydrogen. A mixture of sulphuretted hydrogen and bisulphide of carbon vapor is conducted over zinc dust, which is gently heated. The resulting gas after passing through KOH to absorb undecomposed sulphuretted hydrogen, was found to consist of hydrogen and large quantities of marsh gas.

On the Demonstration of the Flashing Point of Petroleum. J. T. Stoddard. (Vol. XV., p. 2555). Description of apparatus, which is very simple and can be made easily in any laboratory.

Contributions to the Knowledge of the Direct Substitution Products of Azobenzol. H. JANOOSKY. (Vol. XV., p. 2575). The majority of the substitution products of azo-benzol which have been produced within late years were obtained indirectly by reduction of substituted nitro-compounds or by oxidation of substituted amido-compounds, or by diazotation and subsequent combination. By sulphurizing with fuming sulphuric acid of 10-14 % azobenzol-mono-sulpho-acid is produced ($C_{12}H_9N_2SO_3H+3$ aq). By decomposing with iron and acetic acid anilin and amido-benzol-para-sulpho-acid are produced. The formula of the mono-sulpho-acid would hence be $\underset{(1)}{C_6H_5N}=:=\underset{(4)}{NC_6H_4}.SO_3H$.

Three acids are obtained by treating one part of azobenzol with four parts of cryst. acid of 20-30 %. The first or alpha-acid is $C_{12}H_8N_2(SO_3H)_2+3$ aq., or $\underset{(4)}{SO_3H}, \underset{(1)}{C_6H_4N}=:=\underset{(1)}{NC_6H_4}\underset{(4)}{SO_3H}$. It is identical with the acid produced from the nitro-sulpho-acid of benzol (1.4) or from the amido-sulpho-acid (1.4).

The second acid is an amido-benzol-meta-sulpho-acid of the formula :

$$\underset{(3)}{SO_3H}.\ \underset{(1)}{C_6H_4N}=:=\underset{(1)}{NC_6H_4},\ \underset{(3)}{SO_3H}$$

It crystallises with five molecules of water of crystallisation.

The third acid is probably

$$C_6H_3\begin{cases}NH_2 & (1)\\ SO_3H & (2)\\ SO_3H & (4)\end{cases}$$

By decomposition it yields anilin and amido-benzol-disulpho-acid.

On the Recognition and Estimation of Titanium. A. WELLER. (Vol. XV., p. 2592). The author recommends peroxide of hydrogen as a reagent in testing for titanic acid. A few drops of the peroxide added to 1cc of a sulphuric acid solution of titanic acid will produce and orange-red color, when as much as one milligramme of the acid is present, and a distinct light yellow color when 0,0001 grms. is present. Only when the amount is equivalent to 0,0002 grms. the reaction ceases to be distinct. This reaction is employed for a quantitative colorimetric determination of titanium and gives very good results in as much as the titanium can be determined in the presence of zirconium, tantalum and niobium. When, however, vanadic or molybdic acid is present, great care must be exercised, as these acids are also colored when H_2O_2 is added to a solution containing them.

ACTION OF DIAZOANISOLE UPON PHENOLES.

By James H. Stebbins, Jr., F. C. S.

SECOND PAPER.

In my last paper on this subject, I described a compound produced by the action of diazoanisole chloride, upon an alkaline solution of orcine.

At present it is my intention to describe a somewhat similar body resulting from the union of diazoanisole chloride, and resorcine disulphonate of soda.

12. 3 g. anisidine were diazotized with 17.9 g. H Cl (1.20 Sp. Gr.) and 6.9 gr. Na NO_2, in 200 c. c. water.

The diazoanisole chloride thus formed, was added, little by little, and under constant stirring to a solution composed of 18.9 grs. resorcine disulpho acid, 16 grs. Na OH in 200 c. c. water, and 20 c. c. Na OH and Aq. (10 per cent.)

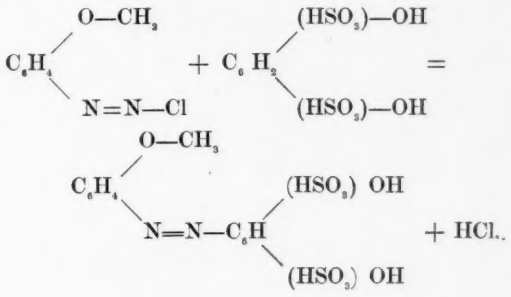
The whole was allowed to rest for a few hours, and then treated with an excess of strong muriatic acid, which precipitated the dyestuff as a free acid.

It was then dissolved in hot water and allowed to crystallize.

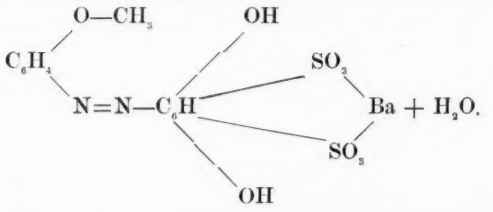
Thus prepared it crystallizes in little fern shaped yellow plates, which are easily soluble in hot and cold water.

RESORCINE-DISULPHO ACID AZO-ANISOLE.

This substance is probably formed according to the following equation :



BARIUM SALT.



This interesting salt, was obtained, by dissolving the free acid in hot water and treating with an excess of Ba Cl_2.

The precipitate formed was collected on a filter, washed and dissolved in boiling water, from which it crystallized on cooling in fine, yellow, star-grouped needles.

In transmitted light this salt has a yellow color, but in reflected light a brick-red shade.

It is sparingly soluble in cold, but readily soluble in boiling water, from which it crystallizes with one molecule water of crystallization.

A barium estimation gave :

Barium.....24.56%

THEORY.

Barium.....24.56%

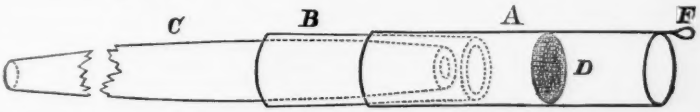
ON A NEW DEVICE FOR DETERMINATION OF CARBON IN CAST IRON.

By A. A. Breneman, S. B.

The carbonaceous residue obtained when cast iron is dissolved is commonly transferred with the mass of asbestos sering as a filter to the combustion tube. To avoid accidents incident to this transfer, and to ensure the combustion of refractory portions of graphite, the writer has adopted the modifications of the process described below. A brief note upon the process was read at the meeting of the American Association in 1879, but the success attending its use since then by students under the writer's direction, as well as the introduction of some minor improvements, has led him to believe that a fuller description of the process might be useful to others. The process depends in the main upon the use of combustion tubes of porcelain, and the employment of a small tube of platinum as a

filtering tube, which is subsequently put with its contents into the combustion tube and heated in a stream of oxygen in presence of cupric oxide in the usual way.

The details of the filtering apparatus will be best understood from the figure.



A is a tube of moderately thick platinum foil, somewhat thicker than that used in blowpipe work. B is a piece of soft rubber tubing fitting snugly within A. C is a piece of glass combustion tubing, tapered at each end as shown, and having a length of about 12 c. m. Other dimensions are as shown in the figure, viz., A 45 × 13 m. m., B 40 m. m. in length. A may vary in dimension according to circumstances.

The apparatus is connected together by pulling or pushing the tube B over the tapering end of C after it has been loosely inserted in A. All pressure upon A is thus avoided. The joint is air-tight. When not in use A is slipped over a piece of glass tubing of proper size to protect it from injury. The loop F serves to introduce a slightly hooked glass rod by which A is moved into the combustion tube or withdrawn from it. The disc D is of platinum foil, perforated, and when in use rests on the end of B within A, and supports the asbestos used in filtration. A small funnel C serves to convey liquids to the filtering tube. The filter with its contents when dry is separated from B and C and introduced into the combustion tube, where it is heated in a current of oxygen as mentioned, in the usual way.

The tube A is easily made in the laboratory, being shaped over a piece of combustion tubing and soldered with gold leaf. It should fit snugly within the porcelain tube, so that oxygen may pass mainly *through* the filter and its contents. It is not difficult to find porcelain tube of a proper size to suit the platinum tube, and in case of difficulty the latter can be enlarged by rubbing it with a stout glass rod while held on a piece of combustion tubing or reduced in size by cutting and resoldering.

The use of porcelain tubes is of advantage not only because of the high temperature attainable, but also because the average *life* of such a tube is greater than that of a quantity of glass combus-

tion tubes costing an equal sum ; with the certainty of perfect combustion that is assured in their use, the convenience of seeing the substance under combustion disappears.

The tubes of platinum seem to suffer little in use. One of them has sufficed for about fifty combustions and is still perfectly good.

ABSTRACTS.

Abstracts from the *Journal of the Chemical Society*, London, by Arthur H. Elliott, Ph. B., F. C. S.

On Oxypropyltoluidine. By H. Foster Morley, M. A., Fellow of University College. (Vol. XL., p. 387).

Propylene oxide was dissolved in an equivalent of paratoluidine, and heated for hours on a water bath. On distilling no propylene oxide was obtained, but at 285°–288° a liquid was obtained, which afterward solidified and by crystallization from benzene gave the formula N (C_3H_7O) (C_7H_7) H. A better yield is obtained when the toluidine solution of propylene oxide is allowed to stand some days at ordinary temperatures. In the latter case 20 grms. of the base were obtained from 46 grms. of toluidine. Oxypropyltoluidine melts at 74° and boils at 293°. It is insoluble in water, soluble in benzene, ether, alcohol, and petroleum. Dissolved in solution of oxalic acid it gives crystals of the formula $C_{10}H_{15}NO,H_2C_2O_4$, which melt at 151°. On heating the oxalate to 150° it melts and gives off water, carbonic oxide, and carbonic acid, leaving a syrup.

Author also gives a description of the distillation of oxypropyltrimethylammonium hydrate. This base (see *J. C. S.*, Vol. XXXVIII., p. 877) resembles neurine when heated giving trimethylamine, propylene-glycol with other liquids, and carbonic acid.

On some Halogen Compounds of Acetylene. By R. T. Plimpton, Ph. D. (Vol. XL., p. 391).

The acetylene was obtained by Jungfleisch's method from coal gas. By passing the acetylene through bromine the author obtained the tetrabromide and a solid C_2HBr_3 melting at 174°. By treating the tetrabromide in alcohol with zinc powder the dibromide was made ; it boiled at 110–111 and at 17° was still liquid. Its specific gravity at 0° C. was 2.268. The di-iodide was made by passing acetylene over iodine wet with alcohol. Crystallized from alcohol, it

gives needles melting at 73°, and distilling without decomposition; it boils at 192°.

Acetylene chloriodide was prepared by passing the gas over iodine monochloride. The crude product was washed, dried and distilled. The chloriodide obtained was a heavy liquid boiling at 119° and has the formula C_2H_2ClI. Acetylene chlorobromide is prepared by adding bromine to acetylene chloriodide under water, dissolving the separated iodine in sodium thiosulphate, drying, and distilling the liquid. It boils at 81°–82°, and has the formula $C_2H_2Cl\,Br$. Warmed with alcoholic soda it gives a spontaneously explosive gas.

Acetylene bromide was made by shaking acetylene with bromine iodide in bottles from which the air had been previously abstracted. The crude black oil is washed with sodium thiosulphate and purified by distillation with steam. It is a heavy colorless liquid, boiling at 150° and solid at 8°.

This paper is accompanied with a table showing the relation of the above compounds to those of ethylene and ethylidine.

On Dihydroxybenzoic Acids and Iodo-Salicylic Acids. By A. K. Miller, Ph. D. (Vol. XL., p. 398).

In this research the author has obtained the sixth acid of the formula $C_6H_3(OH)_2COOH$. Two methods were employed; one by heating catechol with ammonium carbonate and water in sealed tubes, and the other by fusing iodosalicylic acid with potassic hydrate. By the first method very little of the dihydroxybenzoic acid was obtained; but it gave a *pure blue* coloration with ferric chloride, which turned violet red with sodium carbonate. Analysis gave figures for the formula $C_7H_6O_4$. For the second method the author made iodosalicylic acid by the direct action of iodine on salicylic acid. Lautemann, Lischti, Demole and Goldberg, worked upon iodosalicylic acids, but their results were so divergent that the author repeated the work. Having found that Lautemann's and Goldberg's work agreed in some points, the author made iodosalicylic acid by Lautemann's method, by boiling salicylic acid and iodine in alcohol. To separate mono- and di-iodosalicylic acids, the mixture was boiled with barium carbonate and water, and the barium salts crystallized from hot water; but the method did not give definite salts and was abandoned. To effect the separation of two iodosalicylic acids a tedious process of fractional crystallization was undertaken. By this means the two acids were separated, the more insoluble melting at 197° and the other at 198°. The

first of these is paraiodosalicylic acid, it crystallizes from water in long needles, which give a violet color with ferric chloride. The barium salt of this acid crystallizes with 4 mol's of water and dissolves in 120–125 parts of water at 8°. The second more soluble acid obtained above is ortho-iodosalicylic acid; it gives a violet coloration with ferric chloride. The barium salt of the last acid requires 190 parts of water for its solution at 8°, and it crystallizes with $3\frac{1}{2}$ molecules of water.

By fusing the para-acid with potash dihydroxybenzoic acid is obtained, which crystallized in anhydrous needles. Its aqueous solution gives *no* precipitate with lead acetate, gives a deep blue color with ferric chloride, changing to red with sodium carbonate, but destroyed by excess of the reagent. By fusing the ortho acid with potash, another dihydroxybenzoic acid is obtained, which gives a blue color with ferric chloride, but the color is violet red, with sodium carbonate, and not destroyed by an excess of the reagent. This acid also differs from the former in its crystalline form, by giving a precipitate with lead acetate, and by giving catechol and carbonic acid when heated, while the para-acid gives quinol under the same conditions. It melts at 204°, and is the missing dihydroxybenzoic acid.

$$C_6H_3—O^3H—O^2H—COO^1H.$$

The author gives a table of the six dihydroxybenzoic acids, with their properties, etc.

Crystalline Molecular Compounds of Napthalene and Benzene with Antimony Trichloride. By Watson Smith and G. W. Davis. (Vol. XL., p. 411.)

By melting together three parts of antimony trichloride with two of napthalene, minute clinorhombic tables are formed, which are separated from the fluid mass with a warm platinum spatula. When first obtained they are transparent, but soon become opaque. They gave by analysis 38.68 and 38.56 per cent. of antimony, corresponding to the formula $3Sb\,Cl_3$, $2C_{10}H_8$, which requires 38.94 per cent. of antimony.

By dissolving three parts of crystallized antimony trichloride in four parts of benzene with warming; in a few days large inorhombic plates are formed, which are colorless and transparent, and remain so. Analysis gave 43.46 per cent. of antimony and 37.62 per cent. of chlorine, corresponding to the formula $3Sb\,Cl_3$, $2C_6H_6$,

which requires 43.57 per cent. of antimony and 37.90 per cent. of chlorine.

An Additional Evidence, by Analysis of the Quinoline Molecule, that this Base Belongs to the Aromatic Series of Organic Substances. By WATSON SMITH and G. W. DAVIS. (Vol. XL., p. 412.)

By heating quinolene with ten times its weight of antimony penta-chloride in a sealed tube, the author obtained the products of exhaustive perchlorination. Among these products they obtained perchlorethane as white needles melting at 210°, but probably containing perchlorbenzene. By resubliming, a product was obtained melting at 182°, pure perchlorethane melting at 183°. They also obtained perchlorbenzene as white needles, melting at the correct temperature, 223°. No perchlormethane was detected, but this might escape in opening the tubes. These results coincide with the work of Dewar (J. C. S., 1881, p. 1044), who obtained quinolinic acid by oxidizing quinoline, and by heating the acid with soda-lime got aniline, the benzene nucleus with an amido-group; while the present authors obtain the benzene nucleus perchlorinated, and half the remaining residue, containing the nitrogen atom, as perchlorethane.

On Orcinol and Some of the Other Dihydroxytoluenes. By R. H. C. NEVILE and DR. A. WINTHER. (Vol XL., p. 415.)

Believing that Orcinol was a dihydroxytoluene, the authors undertook this investigation. Taking dinitroparatoluene 1:3:5 made from dinitropartoluidine, it was dissolved in alcohol and treated with ammonium sulphide. Water was added and the precipitate dissolved in hydrochloric acid and reprecipitated with ammonia. By further purification thick needles of nitrotoluidine were obtained melting at 98°–98°.4. The yield was 50 per cent. of the dinitrotoluene used. By treating with sulphuric acid the sulphate was obtained; which by further treatment with potassic nitrite gave nitrocresol as a brown oil, which by purification with ether gave yellow needles of nitrocresol. The nitrocresol was treated with tin and hydrochloric acid; after removing the tin, the solution was evaporated, and the crystals obtained washed with ether to remove unreduced nitrocresol. From this chloride dihydroxytoluene is obtained by treating with sulphuric acid and potassic nitrite. The resulting oil purified by distillation and crystallizing from benzene and chloroform, gives

from the first needles or prisms and from the latter white leaves. After 14 days over sulphuric acid it melts at 106°–108° ; which by analysis proves to be orcinol C_6H_3,CH_3, $(OH)_2$ 1:3:5.

The authors have also succeeded in making orcinol from meta-bromo-toluene–metasulphonic acid ; toluene–meta-disulphonic acid ; metabromo–metatoluidine ; metadibromotoluene.

During this research the authors have also obtained the dihydroxytoluene 1:2:4, starting with orthonitro-paratoluidine. This latter was converted in sulphate, treated with potassic nitrite and converted into nitrocresol. This nitrocresol was treated with tin and hydrochloric acid to obtain amido-cresol. The chloride of amido-cresol thus obtained by treatment with sulphuric acid and potassic nitrite and the dihydroxytoluene obtained as an oil, which afterward crystallized, and by sublimation and crystallization gave a melting point of 104°–105°.

The author also prepared dihydroxytoluene 1:2:5 from meta-nitro-orthotoluidine following nearly the same process as in above case. The dihydroxytoluene 1:2:5 obtained is in white leaves melting at 124°–125° and freely soluble in alcohol, ether or water.

An investigation of the dihydroxytoluene 1:3:4 was also made by the authors starting with metanitro-paratoluidine, following the method above used by preparing the diazo compound, but was unsatisfactory. The method of Wagner (Ber. 1874, 537) was used, and by slight modification with success.

The paper is a very lengthy one and filled with most interesting details in manipulation of the methods used.

Abstracts from *Berichte der Deutschen Chemischen Gesellschaft*, by Percy Neymann, Ph. B.

On Hydroxylamin Chloride. V. Meyer. (Vol., XV. p. 2,789.) The author gives a method which can be used on a large scale without the use of platinic chloride. He finds that the presence of ammonium chloride does not impair the durability of the product, but the presence of ferric chloride or free acid cause decomposition of the product, forming ammonium chloride.

On the Behavior of Platinum or Palladium Towards Carbonic Oxide or Hydrogen in the Presence of Oxygen and Water. Moritz Traube. (Vol. XV., p. 2,854.) Not only palladium containing hydrogen but also palladium which is free from hydrogen will oxidize carbonic oxide in the presence of water to

carbonic acid. Peroxide of hydrogen is also formed. Platinum behaves in the same manner. If platinum in the form of foil or wire is shaken with hydrogen, air and water a large quantity of peroxide of hydrogen is at once formed.

Separation of Asparagin from Solution. E. SCHULZE. (Vol. XV., p. 2,855.) Mercuric nitrate when added to a solution containing asparagin will precipitate it. The precipitate can be decomposed by means of sulphuretted hydrogen, again affording asparagin.

Preparation of Indigo blue from Orthonitrobenzaldehyd. AD. BAEYER and VIGGO DRAWSEN. (Vol. XV., p. 2,856.) If a solution of orthonitrobenzaldehyd in aceton is treated with water until a cloudiness appears, and subsequently with soda lye, baryta water or ammonia, the solution at first becomes yellow, then green, and after a time deposits large quantities of indigo blue.

On Aromatic Antimony Compounds and a New Method of Forming Aromatic Arsenic Compounds. A. MICHAELIS and A. REESE. (Vol. XV., p. 2,876.) When sodium is added to a mixture of cholride of arsenic, brombenzol and ether, chemical action at once ensues. On evaporation of the ethereal filtrate an oily residue remains which soon crystallizes. The product recrystallized once from hot alcohol is pure triphenylarsin. This heated with excess of chloride of arsenic in a closed tube for some time at 250° C. gives mono-phenyl-arsenious chloride :

$$(C_6 H_5)_3 As + 2 As Cl_3 = 3C_6 H_5 As Cl_2.)$$

The antimony compounds are formed in a similar manner. Antimonious chloride and brombenzol are dissolved in the appropriate proportions in benzol, an excess of sodium is added and all is heated for some time at the upright condenser. The filtrate upon evaporation and recrystallisation form a large quantity of alcohol, gives a pure stibin.

On the Dopplerite of Aussee. W. DEMEL. (Vol. XV. p. 2,961.) The author, after a series of quantitative analyses and tests to imitate the organic mineral dopplerite, concludes as the most probable, that the mineral is to be recognized as the calcium salt of one or more of the acids of the series of the humus substances.

On Carbonic Acid Hydrate. M. Ballo. (Vol. XV., p. 3,003. In testing a mineral water sold in commerce under the name Salvator, the author was struck by the action of the carbonic acid contained in the same. The water contains 2.35 grms. of free acid to the litre, and notwithstanding this large amount, the water does not sparkle at 8-10° R. It occurred to the author that in aqueous solution the carbonic acid might be present as hydrate. A proof for the existence of carbonic acid hydrate was given, when a metal was found which would dissolve in the carbonic acid solution accompanied by the evolution of hydrogen. Magnesium was found to answer the purpose.

Methylating and Ethylating of Anilin and Toluidin. H. Reinharat and W. Staedel. (Vol. XVI., p. 29.) When the bromine or iodine hydrates are heated with the calculated amount of methyl alcohol and of ethyl alcohol to 145°–150° and 125° respectively, the secondary and tertiary bases are formed respectively. All the compounds are known except the mono-and diethyl-orthotoluidin.

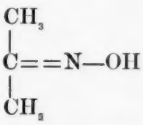
Action of Chlorocyanogen on the Potassium Compound of Pyrrol. G. L. Ciamician and M. Demestedt. (Vol. XV., p. 64.) The authors obtained needle shaped crystals having the melting point 210°. The analyses gave figures corresponding to a formula $C_4 H_4 N—CN$. *i. e.*, cyanogen-pyrrol or tetrol-cyanamid. It is most probable, however, that the product is a polymerid of $C_5 H_4 N_2$ corresponding to the formula 3 ($C_5 H_4 N_2$) and to the name tetrol-c yanuramid or tetrol-melamin. The behavior of this compound is similar to diphenyl-cyanamid, which latter was prepared by Weith (Berichte, Vol. VII., 843) from chlorocyanogen and diphenylamin.

On a New Method of Preparing Carbonic Oxide. E. Noack. (Vol. XVI., p, 75). The method is in brief as follows: A piece of combustion tubing is filled with zinc dust, leaving a channel for the passage of carbonic acid, which is generated in the ordinary manner. It is good to insert a bottle containing soda solution between the combustion tubing and the receiver. The carbonic oxide should be conducted through the bottle containing caustic soda. The zinc dust is not quite allowed to glow. With 200 grms. of zinc 20 litres of carbonic oxide were obtained; 13 litres of carbonic acid gave 11 litres of carbonic acid.

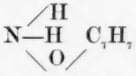
Burning of Sulphur with White Phosphorescent Flame. K. HEUMANN. (Vol XVI., p. 139). The author found that when sulphur is placed on a warmed plate in the dark a white phosphorescence is observed, entirely different from the blue flame occurring when sulphur is burned. Another method of observing the phenomenon is to heat a glass rod and then to dip it into powdered sulphur. If the rod has not been too hot the white phosphorescence is easily observed in the dark. A still better method is to heat the sulphur rapidly on a plate inside of a metallic air bath to 180°. In this manner the phosphorescence can be kept up for hours.

On the Synthesis of Cinnamic Acid according to The Schwartz. E. ERLENMEYER. (Vol. XVI., p.152). The author finds, after various attempts during a period of years, to synthetically prepare cinnamic acid, that phenyl-propianic acid and phenyl-propiolic-acid are the only acids formed. Schwartz probably mistook phenyl-propiolic-acid, which at the time of his publication was not known, for cinnamic acid.

On Isonitroso Compounds. VICTOR MEYER. (Vol. XVI., p. 167. The acetoxine described previously by V. Meyer and Alois Tanney has the formula



Treated with acids it is decomposed into aceton and hydroxylamin. The base must hence have the formula



This can be proven by reducing the Benzyl-hydroxyl-amin with hydriodic acid, forming ammonia and iodobenzyl.

$$NH_2OC_7H_7+H_2=C_7H_7OH+NH_3$$

On Paraxanthin, a New Component of Human Urine. G. SALOMON. (Vol. XVI. p. 195.) The method employed for obtaining the xanthin compounds was that given by Salkoweski and Leube, "Die Lehre vom Harn" (Part I., p. 105). The last product, formerly supposed to be the xanthate only, and consisting of a silver salt, was decomposed by sulphuretted hydrogen. The remain-

ing phosphates and a small quantity of oxalate of lime were then removed, the solution slowly evaporated on a sand bath until the xanthin, which is soluble, with difficulty separated. This was then filtered off and from the filtrate the paraxanthin was obtained by evaporating to crystallization. The formula is most probably $C_{15}H_{17}N_9O_4$.

Action of Chinolin on Chloroform and Iodoform. O. O. RHOUSSOPAULOS. (Vol. XVI., p. 202.) If chinolin is allowed to act on chloroform no reaction takes place even when the substances are heated together in a sealed tube to 250° for several days. At 300° the substances act partially only. If, however, iodoform is used, a reaction takes place easily at common temperature, forming a methan-trichinoil-ido-hydrate, $CH(C_9H_7NI)_3$.

On the Sesquicarbonate of Potassium. C. RAMMELSBERG (Vol. XVI., p. 273.) While the sesquicarbonate of sodium occurs as Troua (Ural) in the salt lakes of Africa and South America, no reference is found on the potassium salt. According to G. H. Bauer it has been found in a mineral water establishment of Dr. Struve & Holtmann in consequence of evaporation and crystallization of large quantities of bicarbonate solution by Dr. Lichtenstaedt. The crystals are not moist and do not decompose. They are—

$$\left.\begin{matrix}2K_2CO_3\\H_2CO_3\end{matrix}\right\} + 3aq.$$

	Bauer's analysis (*a*).	Rammelsberg's analysis (*b*).	
	(*a*)	(*b*)	Calculated.
Potash	46.54	46.59	47.96
Carbonic acid	21.79	21.80	22.39
Carbonic acid	11.54	12.22	11.20
Water			18.45
			100.00

On Oenanthalanilin, Oenanthalxylidin and Oenanthalnaphtylamin. A. R. LEEDS. (Vol. XVI., p. 287.) 70 grms. oenanthal and 57 grms. of anilin were mixed gradually. The temperature greatly rises (from 27° to 89°).

70 grms. of oenanthal and 74 grms. of xylidin were mixed for preparation of oenanthalxylidin.

70 grms. of oenanthal were added to 88 grms. of naphthylamin, in consequence of which the latter rapidly melted a liquid having been formed of the temperature 75°. All three compounds were

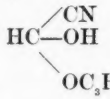
heated for six hours at the upright condenser. The best method for purification was found to be as follows: Each of the three compounds was dissolved in about 150 grms. of glacial acetic acid and heated for several hours on the water bath. Then water was added in large excess which precipitated, the oenenthal, anilin-xylidin-naphthylamin respectively leaving the acetates in solution. The analyses of all three corresponded to the formulæ: Oenanthalanilin $C_6H_7NC_7H_{14}O$; Oenanthalxylidin $C_6H_{11}NC_{17}H_{14}O$; and Oenanthal-naphthylamin $C_{10}H_9NC_7H_{14}O$.

On Cryptidin. A. R. Leeds. (Vol. XVI., p. 289.) An oil was obtained by distilling 155 grms. of xylidinacrolein in portions of 20 grms. No note was taken of the temperature of distillation until it had reached 360°,11 grms. or about 7% of the oil were obtained. The oil has a disagreeable odor and a very bitter taste. It forms crystalline salts with sulphuric, hydrochloric and other acids. The best method of purification is to decompose the hydrochloric acid salt with alkali. The purified and dried oil has the boiling point 270°. It has a reddish color. The analysis corresponded to the formula of cryptidin: $C_{11}H_{11}N$.

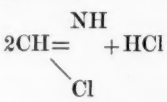
On the Action of Phtalic Acid-Anhydride on Chinolin. M. C. Traub. (Vol. XVI., p. 297.) As shown by O. Fischer it is easy to extend the phtaleïn reaction on dimethylanilin as a confirmation of the similar action of phenols and tertiary aromatic amines. The author endeavored to further extend these reactions to tertiary aromatic amines, the nitrogen of which has entirely different combining conditions from that of dimethylanilin, mainly to pyridin and chinolin bases. When phtalic acid anhydride is treated with chinolin 3 to 4 hours at 150° a reaction takes place. After removal of excessive chinolin a sticky mass remains, which is purified by glacial acetic acid and crystallized from benzol. The analysis shows that a reaction similar to the anthrachinon formation has taken place. The formula being $C_{17}H_9NO_2$, the compound is termed chinophtalon by the author.

On the Combinations of Hydrocyanic Acid with Hydrochloric and Hydrobromic Acids. L. Claisen and F. Matthews. (Vol. XVI., p. 308.) Some time ago it was observed by Pinner and Klein, that when hydrochloric acid was passed into an alcoholic solution of hydrocyanic acid diethyl-glyoxylic acid was formed besides other products. Claisen and Matthews supposed that the reaction took place as follows: formic ether is at first

formed, and this in the same manner as the aldehyds combined with the hydrocyanic acid to a nitrite.



and that this was converted into the glyoxylic acid derivative by the action of the alcohol and the hydrochloric acid. The authors could not prepare such a product from formic ether and hydrocyanic acid, but found that hydrochloric acid is greedily absorbed by the mixture, giving rise to a double compound of hydrocyanic and hydrochloric acids. $2CNH+3HCl$ is the resulting compound. The formic ether plays no part, as the reaction takes place in presence of any other ether (benzoic ether, acetic ether.) The reaction takes place at as low a temperature as 15°. The constitution of this compound is probably best expressed thus :



The hydrobromic acid compound is similarly obtained.

Hydrocyanic acid and fuming hydrochloric acid were mixed in the proportions, so that for one mol. of hydrocyanic acid, exactly one mol. of water was present. After proper treatment, an oil with boiling point, 190–210°, is obtained, which, according to a nitrogen determination, was found to be formamid. Contrary to previous statements, hydrocyanic acid can be converted into the corresponding amid by careful treatment with hydrochloric acid.

Formation of Arsenides by Pressure. W. SPRING. (Vol XVI., p. 324.)

The author publishes a series of experiments and results obtained by pressing pulverized arsenic separately with various metals.

Zinc arsenide.—A mixture of zinc filings and pulv.-arsenic, in the proportions expressed by the formula Zn_3As_3, was subjected to a pressure of 6,500 atmospheres. The resulting block was again filed and repressed. A homogeneous bright metallic mass was obtained. The elevation of temperature plays no part, being but very slight; hence zinc and arsenic combine by mechanical energy alone.

Lead arsenide.—After two pressures of the mixed filings, the

mixture corresponding to the formula Pb_2As_3, a homogeneous block of metallic lustre was obtained. It is hard and brittle.

Tin arsenide.—This is very easily formed, even when mixed in different proportions. When mixed in the proportions corresponding to Sn_3As_4, a white metallic mass is obtained, brittle, and melting with more difficulty than tin.

Cadmium arsenide.—After three pressings the combination was complete. From experiments the author finds that by pressure a better alloy can be obtained than by melting the metals together. This is probably because the dissociative tension of the arsenides is so great as to prevent a good combination.

Copper arsenide.—This is not as easily formed as the preceding alloys. After a first pressing of a mixture corresponding to the fomula, Cu_3 As_2 all particles of copper and arsenic can be found separately. After about eight pressings the mass becomes homogeneous of metallic lustre, brittle and fine grained. The mass has a whitish-gray lustre.

Silver arsenide.—This is as difficult to form as the copper arsenide. The mass becomes homogeneous, very brittle, has a metallic lustre, and a gray-bluish color.

Arsenic alone in the amorphous state when subjected to 6500 atmospheres pressure, changes its appearance and becomes metallic on the surface. About one-fourth is converted into crystalline form

On the Action of Phosphorus Chlorides on Phenanthrenchinon. B. Lachowicz. (Vol. XVI., p. 330.) Phosphorus pentachloride and phenanthrenchinon react upon each other vigorously when slightly warmed and a crystalline mass is formed. It is purified by crystallization from chloroform and dried over sulphuric acid. The formula to which the analysis corresponds is C_{14} H_8 O Cl_2. The reaction takes place as follows:

$$\begin{matrix} C_6H_4\text{—}CO \\ | \quad\quad | \\ C_6H_5\text{—}CO \end{matrix} + P\,Cl_5 = \begin{matrix} C_6H_4\text{—}C\,Cl_2 \\ | \quad\quad | \\ C_6H_4\text{—}CO \end{matrix} + PO\,Cl_2$$

The author terms this compound phenanthrendichlor-keton. Its melting point is 165°.

On Allyl-succinic Acid and a Carbo-caprolactonic Acid. Edw. Hjelt. (Vol. XVI., p. 333.) The allyl-succinic acid was obtained synthetically from malonic-acid-ether. By action of sodium ethylate and chlroro-acetic ether on malonic-acid-ether the ethenyltricarbonic-acid-ether was produced and the allyl group

was introduced into this. The allyl-ethenyl-tricarbonic-acid-ether boils between 280° and 290°. From the barium salt the acid was obtained pure. The formula according to analyses is $C_8 H_{10} O_6$. When treated with hydrobromic acid this acid gives a crystallized acid, which melts at 159°, at 160° this loses carbonic acid. The residue allyl-succinic acid solidifies and is obtained pure by crystallization from alcohol. Its formula is $C_7 H_{10} O_4$ and is isomeric with teraconic acid. When heated to 250°, water is at first separated and oil distills over, which in contact with water again forms ally-succinic acid. The acid dissolves in forming hydrobromic acid. By treating with water and extracting with ether, and acid oil, free from bromine is obtained, which crystallizes in vacuo. This acid was found to be the lactonic acid, of the formula $C_7 H_{10} O_4$.

PROCEEDINGS OF THE AMERICAN CHEMICAL SOCIETY.

Regular Meeting May 4, 1883.

At Mr. Stebbins' request Prof. Leeds occupied the chair.

The minutes of the February meeting were read and approved.

The minutes of the meetings of the Board of Directors, held January 16, 1883, and March 20, 1883, were also read.

The following papers were read :

1. On apparatus for producing high vacuum with low pressure, by C. J. Lawler.

2. Platinic Iodide as a test reagent for deleterious organic substances in potable waters, by Dr. A. R. Leeds.

3. A note by Dr. Breneman, on a "Eudiometer for Rapid Gas Analysis."

4. A note by Prof. A. R. Leeds, on "The Conversion of Carbon Monoxide to Dioxide by Active (*i. e.* Nascent) Oxygen."

The papers were followed by discussion participated in by Messrs. Stebbins, Casamajor, Alsberg and Leeds, after which the Society adjourned.

THOMAS S. GLADDING,
Recording Secretary.

NEW ASPIRATOR, CAPABLE OF GIVING A HIGH VACUUM WITH A LOW WATER PRESSURE.

BY C. J. LAWLER.

In the London *Engineer* for 1876, Mr. Bronson has described an aspirator, giving results which are about the same as those obtained with the apparatus which I propose to describe. The only merit claimed for the new aspirator is its greater simplicity.

With the new apparatus a vacuum equal to the barometer vacuum may be obtained, minus the tension of the water vapor corresponding to the temperature of the water used to work the apparatus.

This result can be reached with a water pressure not exceeding 5½ pounds.

The good results obtained with such very low water pressure, by means of an apparatus of very simple construction, have been

received with great favor by several friends, who have urged that the publication of the results obtained would be useful and interesting to other chemists.

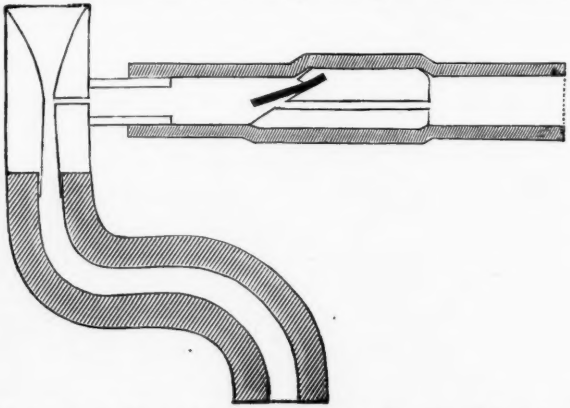
Experience has shown that a high vacuum is not necessary for filtration, but for other purposes, such as fractional distillation, a high vacuum is a great help.

High water pressure cannot be obtained in many laboratories, especially those situated in the lower part of New York city, and chemists constantly complain that they are unable to secure a vacuum with their filter pumps.

In order to get an aspirator which gives the best results with lowest water pressure, it is simply necessary to adapt a few well-known principles in Hydrodynamics to the end in view.

A volume of water thirty-four feet high will support a column of mercury thirty inches in height. In order to do the same amount of work with a less "head" of water, a greater volume of the liquid must be employed. As a mass falling from a given height exerts a definite amount of energy in its fall, to secure the same amount of energy from a body falling from a lesser height, the mass must be increased, *i. e.*, the mass must be inversely proportionate to the height.

We must also consider that the form of tube or nozzle which has the greatest co-efficient of discharge must give the best results.



This shape, as shown by Venturi, is a tube whose interior presents the appearance of the frustrum of a cone, the sides of which diverge at an an angle of five and sixteen one hundredths degrees,

and whose length is nine times that of its lesser base. The discharge in this case is 2.5 times greater than through a thin plate, 1.9 times greater than through a short cylindrical tube, and 1.46 times greater than the theoretic discharge (Haswell).

The water enters the aspirator through a short funnel, whose sides converge towards the narrow part of the cone. The aspirating hole is at the junction of the cone and funnel, and should not be more than one-third the diameter of the throat of the apparatus.

Conical diverging arteries give their best results when submerged, but, as this is not convenient in the case of aspirators, the same end may be attained by attaching to the extremity of the pump a short piece of lead-tubing of slightly larger calibre than the discharge, bent at least twice at right angles.

The efficiency of this pump is shown by the following comparison with that of Prof. Richards (Chem. News, 1876, pp. 141.) The barometer standing at 29.8 inches, temperature of water in hydrant 47° Fah.

Water pressure.	New pump.		Richards' pump.	
1 pound	4.8 inches	Mercury	1.0 inches	Mercury
2 "	10.7 "	"	1.6 "	"
3 "	17.8 "	"	2.3 "	"
4 "	24.7 "	"	2.8 "	"
5 "	29.2 "	"	3.4 "	"
5½ "	29.4		3.8 "	"
25 "			29.2 "	"

No disparagement is intended in this comparison to Prof. Richards' aspirator, which was designed for high pressures, and which works admirably with a pressure of twenty-five pounds.

While it was an easy matter to get the necessary data for the construction of the aspirator, it was a matter of no little difficulty to get a workman that would rigidly adhere to these data. Fortunately I found in Mr. Ketchum, 171 Gates Avenue, Brooklyn, a person qualified for the work. To this gentleman I am also indebted for designing an ingenious and efficient check valve, which is a necessary adjunct to all aspirators which work with water-pressure. His method of setting the valve is also very ingenious. A piece of brass rod, one-quarter inch in diameter, and one-quarter inch long, is bored, turned and filed to the shape shown in cut. A small piece of thin sheet rubber, one-sixteenth inch smaller than the face of the valve, is permanently fixed to its seat by a lug cut in the upper

part of the face, this is placed in the end of the piece of rubber tubing which is attached to the aspirating tube, by first introducing a thin metal tube, whose internal diameter is slightly larger than the diameter of the valve. The latter is then dropped into the tube, and by means of a small rod, pushed into place just beyond the metal tube which is then withdrawn. The rubber tube embraces the valve so securely that it is impossible to displace or disarrange it. This method is superior to the older one of cementing the valve in the aspirating tube.

A pump actuated by water-pressure has some advantages over the Bunsen Pump which are worthy of attention. It is less expensive, less difficult to place in position, the degree of vacuum is easily regulated by turning on just sufficient water to secure the desired result, avoiding pinch-cocks which injure the rubber tubing, it is not liable to freeze, because there is no great length of pipe to be exposed, an attachment for producing a blast can be added with less trouble and expense.

PLATINIC IODIDE AS A TEST-REAGENT FOR DELETERIOUS ORGANIC SUBSTANCES IN POTABLE WATERS.

By Albert R. Leeds.

In the Chemical News 43, p. 180, M. Field has proposed to employ the reaction of certain organic substances upon a very dilute solution of platinum iodide in solution of iodide of potassium, and by their effect in the removal of the rose-color of this solution, to determine the fact of their presence in greater or less amount. Although the author proposes to employ the test only, or chiefly to establish the fact of the freedom of the water under examination from sewage contamination and from albuminous matters, yet the establishment of this fact alone is of the highest importance. The introduction of specific tests for the various kinds of organic matter, fresh or partly decomposed, which might possibly be present in potable water, would mark an advance in the practice of water analysis, and any proposition looking in this direction merits careful study.

After verifying Field's statements as to the decolorising effect of

certain of the most important organic substances upon platinum iodide solution, I compared the results arrived at by the use of platinum iodide and those obtained by the customary methods of water analysis. Moreover, regarding it probable that the platinum salt would undergo reduction in presence of organic matter when exposed to sun-light, I exposed the tests in a duplicate series of determinations to the action of sun-light, and found my anticipation confirmed. The experiments were made upon a series of samples, the other constituents in which had been determined with exceeding care. In the first series a test solution was made of the same strength as that employed by Field, or one part of platinic chloride in 500,000 parts of a very dilute solution of potassium iodide; 50 c.c. of this solution was added to 100 c.c. of the natural water under examination, and allowed to stand in diffused light for 24 hours. In the second series, 1 part of platinic iodide was dissolved in 200,000 parts of a dilute solution of potassium iodide, and 100 c.c. of this solution added to 100 c.c. of the samples of water, and the solutions exposed in wide comparison-tubes for 48 hours to the sun-light. The results were as follows :—

	In diffused light	In sun-light
Sample No. 227*	Very faint pink	Light rose
" 230	Pink just visible	Pink
" 231	No color	Smoky pink
" 234	Decided pink	Rose
" 235	Faint pink	Rose
" 228		Dark rose
" 232		Faint pink with deposit of platinum
" 233		Smoky pink

It will be noted that in the second series, samples 231, 233 and 232 were so far reduced that a grayish deposit of platinum was formed on the walls of the tubes. In the last, this deposit was tested first with concentrated nitric acid, in which it would not dissolve, and afterwards with aqua regia, in which, after heating, it dissolved to a deeply-colored yellow solution. Since the 100 c.c. of platinic iodide solution was nearly decolorised, the amount of metallic plati-

* These laboratory numbers refer to a series of samples taken from the Schuylkill River in the month of January, 1883, when the water-supply of Philadelphia became so nauseous that I was requested by the water department of that city to investigate the causes of its temporary non-potability.

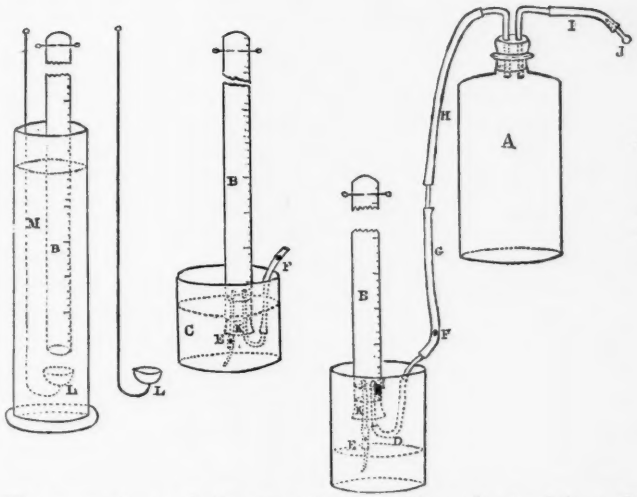
num precipitated amounted to nearly 5 mgrms. In other words, in badly polluted waters the reduction of the platinum salt in sun-light might be employed as a means for estimating the relative amounts of those organic bodies which are capable of effecting such a reduction in sun-light. It was noted, however, that 100 c.c. of a solution of 1 part of platinum iodide in 500,000 parts of a very dilute solution of potassium iodide in *distilled* water became perceptibly lighter in tint when exposed along with the others for the same period of 48 hours. Inasmuch as the solutions were somewhat warmed by the sun-light, and heat has some effect in the removal of the color, this disturbing element would have to be guarded against.

Since this time, an actinic method of determining the putrescible organic matter in potable waters has been regularly employed, and proven so satisfactory, that further experiments with platinic iodide in this direction have been abandoned. But the new ground broken by Field in the domain of water-analysis, deserves to be sedulously cultivated, and the search for specific tests for particular contaminating substances should be carefully followed up.

ON AN APPARATUS FOR RAPID ANALYSIS OF GASES.

By A. A. Breneman, S. B.

The apparatus here described is designed for rapid analysis of gaseous mixtures where only a moderate degree of accuracy is required. It is possible nevertheless to secure very good results with it, if it be carefully handled and if its known source of error be guarded against. As an example of the results that may be obtained with it, two analyses of air may be quoted which yielded respectively 21.04% and 21.13% by volume of oxygen instead of 20.96% which is probably a fair average for the most accurate analyses. The oxygen was absorbed by a solution of pyrogallic acid in caustic potash, in the proportion of 2 grms of the solid acid to 5 c.c. of a solution of K H O (sticks) in twice its weight of water and 10 c.c. of water were further added to the solution. The absorption of oxygen in each case, occupied about 12 minutes. The excess of oxygen indicated is probably to be accounted for by the solution of part of the gaseous mixtures in the water used for rinsing, but the error belongs to all absorption-methods of analysis, where the gas is measured over water.



The apparatus and its use will be readily understood from the accompanying diagram. A is a bottle holding a liter or more. It is closed by a soft rubber stopper carrying two tubes, one of which communicates with a water air-pump, the other with the gas burette. After exhausting the bottle at the pump, the tube I is closed by the stopper is already closed by a bit of stirring rod, plugging the rubber tube G at F and serving also as a valve. It is opened by simply pinching up a portion of the rubber tube about it, thus forming a channel around the plug. The gas burette B is closed by a rubber stopper K, carrying two tubes, one of which connects with A, the other carries a valve at E and a pointed tube of glass at its end.

The gas burette is filled with gas over the pneumatic trough C, the cork K being removed. It is then transferred by means of the deep spoon L to the measuring cylinder, the volume of the gas is noted with the existing temperature, the burette is again brought to the trough, K is inserted and then by opening the valve F the level of water in the burette is brought to the inner surface of the cork K, the water passing into the exhausted bottle L. This bottle is used in the same way, subsequently, to receive all drainings and rinsing water from the burette.

The absorbing liquids are introduced by bringing the point of the tube below E into the liquid and opening E; liquid rushes into the partially exhausted tube to replace the water previously withdrawn.

The burette is shaken to distribute the liquid over its sides and more of the liquid is introduced as the absorption proceeds. When absorption is complete the liquid is withdrawn as before, the tube is rinsed with successive small quantities of water, and the gas finally measured again over water in the cylinder M.

The obvious errors of the apparatus are the entrance of air about the cork K, and separation of gases from the liquids used in the burette when the level of the liquid in the latter is reduced. A soft, well fitting rubber stopper will remove the first objection and as an additional precaution the mouth of the burette is kept below the surface of the water whenever it is not necessary to manipulate the burette. In practice the entrance of external air through leakage is inappreciable during the time of the analysis.

The second source of error is avoided by using such quantities of absorbing liquids that the diminution of pressure within the burette may be slight. During the time of greatest exhaustion, that is during the withdrawal of liquids, the current tends to carry minute bubbles that may separate downwards and into the bottle, and with a good vacuum (20-25 inches of mercury) in the latter, the time is too short to permit of any important volume of gas separating from the liquid.

THE CONVERSION OF CARBON MONOXIDE TO CARBON DIOXIDE BY ACTIVE (*i. e.* NASCENT) OXYGEN.

By Dr. Albert R. Leeds.

In the early part of the year 1879, I was led by certain theoretical considerations to regard it as eminently probable that carbonic oxide would be converted by nascent oxygen into the highest stage of oxidation, and that by properly devising the nature of the experiments, and adequate precautions in the execution of their details, the direct oxidation of carbon monoxide to dioxide by nascent oxygen at ordinary temperatures could be demonstrated. Repeated trials amply justified these anticipations. The final experiment, some account of which will be found in the Jour. Amer. Chem. Soc., I, 232, was performed as follows: A 5-liter jar, containing 5 sticks of phosphorus and a little water, was filled with 2500 cc. of carbonic oxide, and the remaining space with air. The carbonic

oxide was generated from potassium ferrocyanide and sulphuric acid, and washed with water, caustic potassa, and barium hydrate. On transferring it to the jar, it was again washed through a similar train of purifiers, a final V-tube filled with barium hydrate solution remaining pellucid, proving absence of any trace of carbon dioxide. The air was purified in the same manner. At the expiration of 18 hours, the gases remaining above the moist phosphorus in the jar were drawn, first through a moist cotton filter, then through a potassium iodide solution, and finally through two baryta waters. The faint rose coloration which the iodide solution struck with starch water, was found on titration to correspond to 0.04 mgrms. ozone in the total volume of gas drawn over. The last baryta was absolutely pellucid, the first had absorbed 14 mgrms. carbonic acid. The carbonic acid estimation was made by decomposing the barium salt, and weighing the carbonic acid evolved, for fear that some traces of oxides of phosphorus might have escaped from the purifiers, and entered into combination with the baryta.

Later on, further details as to precautions employed in these experiments will be given, in connection with the adverse criticisms to which they have been recently subjected.

Somewhat later in the same year, a related field of experiment was entered upon. This was to determine conclusively, whether or no the triatomic molecule of oxygen was capable of effecting what the individual atom of oxygen, at the moment of dissociation of the molecule of oxygen, had been demonstrated to be capable of doing. It should be premised, that the decompositions and recombinations which occur when phosphorus is oxydized at the expense of, and with simultaneous reduction of the oxygen molecule, are complicated in their nature. An operose determination of the factors of this reaction (Jour. Am. Chem. Soc., I, 146 and II, 37), has shown that it may be represented by the equation

$$aP + bO + cN + dH_2O = a^1P_2O_3 + a^2P_2O_5 + b^1O_3 + c^1(NH_4NO_3) + c^2$$

(NH_4NO_2 subsequently oxydized to NH_4NO_3) $+ d^1H^2O^2$.

The actual values of the coefficients would depend, as was shown in another place, upon the temperature at which the reduction of the oxygen molecule is effected, and the values, a, b, c, d, of the members of the equation. But the important point established was that ozone, hydrogen peroxide, and nitro compounds of ammonia, were always formed, and their quantities always bore a certain relation to one another. Moreover, that the explanation of these

facts could be found only in the supposition of the formation of active oxygen, and the subsequent generation of ozone was no more an essential feature of the reaction than the contemporaneous and invariable production of hydrogen peroxide, and ammonium nitrite and nitrate.

In some earlier experiments, which had been performed with great care by Profs. Remsen and Southworth,* the conclusion had been arrived at that carbonic monoxide was not oxidized to carbon dioxide by ozone.

As above stated, I was induced to renew the investigation,† inasmuch as certain preliminary experiments, which I had performed, had shown that carbonic oxide might undergo conversion into carbonic acid, under the same circumstances which brought about the oxidation of the oxygen molecule to the state of ozone. These were notably two : 1st. The oxidation of carbonic oxide by nascent oxygen, evolved in an atmosphere of moist air over phosphorus, as detailed above. 2d. The simultanous formation of carbonic acid and ozone in a mixture of carbonic oxide and oxygen, subjected to the influence of the silent electrical discharge. Without pausing to rehearse *in extenso* the experiments by which this latter point was established, it will suffice to state that a quantitative determination resulted in showing that after 1½ liters of carbonic oxide had been submitted to the action of the silent discharge, in company with oxygen, 0.0271 grms. (misprinted 0.0271 mgrms. loc. cit.) of carbon dioxide had been formed.

Moreover, I had been enabled, by the use of a modified form of Siemens' ozonizer, to make use of large volumes of oxygen, raised to a higher degree of ozonation than the ozonized gas hitherto employed, and I thought that the theoretic importance of the subject warranted the institution of a fresh attempt to discover whether, with ozone of this degree of concentration, no oxidation of carbon monoxide occurred.

The actual experiment was conducted as follows :—

Oxygen, previously freed from every trace of carbon dioxide, was ozonized by passage through an ozonizing battery to the extent of 72 mgrns. of ozone per liter. It was then passed in excess, together with carbon monoxide likewise completely purified, through a tube one meter in length, which was placed *beyond* the ozonizer. But although the current of mingled ozonized oxygen

* Am. Jour. Sci., III, 11, 136.

† Jour. Amer. Chem. Soc., I, 450.

and carbon monoxide was made to flow with a very slow current, and though the experiment was continued for many hours, the baryta water through which the mixed gases finally made their escape, remained entirely pellucid. In other words, oxygen containing a very large percentage of free ozone, is not capable of effecting the oxidation of carbon monoxide.

Commenting upon this result, the inference was drawn :—"In this case, the energy of combination of the two bonds, presumably free, of the carbon monoxide molecule, appears to be of less valency than the energy with which any one atom in the ozone molecule, is retained by the other two. In the two former instances" (the oxidation of carbon monoxide by nascent oxygen, and the generation of carbon dioxide in a mixture of carbon monoxide and oxygen submitted to the silent discharge) "the ozone molecules are in the process of formation, and in the pre-existant stage (in which the oxygen molecule undergoes dissociation,) the liberated oxygen atom is seized upon by the unsaturated carbonic oxide."

Subsequently* these views were still further generalized in an essay which had for its object the quantitative investigation of the various factors in the complicated reactions connected with the oxidation of phosphorus in moist air. It had previously been shown† that the amount of ozone produced by the oxidation of phosphorus under given circumstances, is constant for any particular temperature, and consequently, the generation of ozone may be graphically represented by a curve, the production at 6° C., being nil, rising to a maximum at 24°-25° C., and then rapidly diminishing as the temperature approaches 44° the melting point of phosphorus. As additional proof of the constancy of the phenomena occurring in the oxidation of phosphorus in moist air, it was established in the progress of this essay, that the amounts of ozone and hydrogen peroxide bear a constant relation to one another and to the air passed over. A similar proposition holds true of the phosphoric and phosphorous acids, and of the ammonia and nitric acid—the amounts of the latter bodies being in the ratio requisite to form ammonium nitrate. Later on it was shown that, neglecting the small amounts of hydrogen peroxide, which were held back by the wash-waters through which the escaping gases pass, the ratio of the hydrogen proxide generated, was to that of the ozone as something over one to three, under the conditions of that particular experiment.

* Jour. Am. Chem. Soc. II., 34.

† Jour. Am. Chem. Soc. I., 8.

These various results caused me again to reiterate the wide generalization which had been brought forward in the earlier articles concerning the production of ozone under the conditions studied :—that it was connected with the uneven qnantivalences of the elements taking part in the reaction. "If this hypothesis be true, then we should anticipate the development of ozone whenever oxidation of a perissad occurred at temperatures compatible with the stability of the ozone molecule. Even at the temperature of combustion of hydrogen, this is supposed by C. Than to be the case. He explains in this manner the presence of the ozone, which he states he has detected in the combustion of hydrogenous substances generally, and its absence in the combustion of carbon."

"In entering into new combinations, the oxygen molecules must undergo temporary resolution into their constituent atoms. These while *en route* to take up new positions in other combinations, and animated by their atomic energy, or energy of the nascent state, may either oxidize the oxygen molecule, or the nitrogen molecule, or the molecule of water. In the first place, ozone would be produced ; in the second, regarding water as the basic body and NNO as the nitryl, there might be formed, as Hunt has indicated, ammonium nitrate ; in the third, hydrogen peroxide."

This recapitulation is here given in order to recall the gradual evolution of the hypothesis of the necessary existence of active or nascent oxygen, as a body distinct from ozone, in order to explain observed phenomena. According to these views, the oxidizing effect of palladium-hydrogen, as noted by Hoppe-Seyler, at a later period in the history of these researches,* was a particular case of the oxidation of a perissad (in this case hydrogen) at a temperature especially compatible with the stability of the ozone molecule. The intervention of nascent hydrogen, or active hydrogen, is not needed to explain the production of hydrogen peroxide when hydrogenium or palladium-hydrogen comes in contact with water. Hydrogenium is a perissad metal endowed with the most eminent deoxidating or reducing powers. When it reduces the molecule of oxygen, a temporary resolution of the molecule into its constituent atoms must necessarily take place. In other words, hydrogenium stands in the same relation to the production of hydrogen peroxide, as phosphorus does when oxidized in presence of moist air. Like the phosphorus it directly reduces the oxygen molecule, and sets free the oxygen

* Activation of oxygen by nascent hydrogen. Ber. der deutsch Chem. Gesell., XII, 1551.

atom. This active oxygen so formed, is the efficient cause of all the subsequent phenomena. It starts the series of chemical changes, and is the principal and all important factor, as related to which and resulting from which, the generation of the ozone, hydrogen peroxide, and ammonium nitrate and nitrite, are three correlative and necessarily dependent, but inevitably and indissolubly connected, consequences. According to this hypothesis, the generation of ozone is not the central fact around which the possible formation of active oxygen and the other phenomena are grouped, but it is a secondary phenomenon and is of no more importance so far as the theory of the reaction is concerned, than the simultaneous development of hydrogen peroxide, and, in presence of nitrogen, of nitrogen compounds.

The foregoing history of previous investigations is given, in order to render intelligible the attitude in which I stood with regard to the statements recently made by Profs. J. Remsen and E. H. Keiser in a paper "On the Conduct of Moist Phosphorus and Air towards Carbon Monoxide" (Amer. Chem. Jour. IV, 454). It will be further necessary only to state that my views are not the same as those advanced by Hoppe-Seyler, as may be seen from the different induction which I drew from Hoppe-Seyler's own experiments. For in his original experiments this investigator did not suspect the necessary presence of peroxide of hydrogen, as an indispensable factor in the reactions observed. Subesequently (Ber. der deutsch Chem. Gesell., XIV, 976) I pointed out that this must be the case, and on performing the experiment, quantitatively determined the amount of peroxide formed. The only reasons for previously anticipating, and actually performing the experiments comfirmatory of the presence of hydrogen peroxide, were the theoretical considerations connected with the development of active oxygen above enunciated. Ignoring these results, M. Traube in a later issue of the Berichte (XV, p. 659) brought forward the formation of hydrogen peroxide under these circumstances, as his own observation, and has founded upon this production of hydrogen peroxide a hypothesis concerning the validity of which, and concerning the experimental verification of the experiments upon which it is based, I shall defer writing until the publication of a subsequent article.

After recounting certain preliminary experiments, the crucial one, by which Remsen and Keiser hold that they have conclusively established the non-conversion of carbon monoxide to dioxide in the presence of moist air and phosphorus, and so far as the evidence

afforded by this experiment is concerned, the non-existence of active oxygen, is stated (by them *loc. cit.*), as follows:

"An apparatus was finally constructed in which these were entirely excluded, or, at least, so protected that the ozone could not possibly reach them. Although a number of different forms of apparatus were tried, we need only describe that which we finally decided upon as the best. This consisted of a flask of from three to four liters capacity, provided with a doubly perforated cork stopper. Through this there passed one glass tube reaching to the bottom of the flask, and another reaching only half way. Outside the flask the shorter tube was connected with the apparatus intended to remove the carbon dioxide from the air, and the longer tube was bent twice at right angles, and then passed through the stopper of a V-tube about eight inches high. Between this V-tube and a second like it, connection was made by means of a doubly bent glass tube. In the flask there were placed usually two or three sticks of phosphorous, each three or four inches long, and enough pure water to somewhat more than fill the neck when the flask was inverted. The V-tubes were filled with ignited asbestos, and there was then added some mercury, so that when the tubes were inverted, in which position the entire apparatus was placed when in use, the metal covered the corks with a layer from three-quarters of an inch to an inch in thickness. The connecting tubes passed, of course, in each case through the layer of mercury. The vessel containing the clear baryta water was also connected with the last V-tube by means of a mercury joint similar to those above described. The baryta water was protected from the action of the air by placing before it a small V-tube containing potassium hydroxide, and this last tube was connected with an aspirator. Before connecting the bulbs containing the baryta water, air freed from carbon dioxide was drawn slowly* through the apparatus. On now connecting with the baryta water bulbs no precipitate was formed. Even on allowing the air to remain in contact with the moist phosphorus for periods varying from one to twelve hours, no carbon dioxide could be detected. This experiment was tried over and over again at different temperatures, but always with the same result.

About one-third of the air in the ozone flask was now replaced by carbon monoxide, from which all dioxide had been scrupulously re-

* This operation requires care and constant attention. The phosphorus not unfrequently takes fire. In one case in our experience it took fire after having stood quietly and unmolested for several hours.

moved. The mixture was allowed to stand for some hours and then drawn through the baryta-water bulbs, when no precipitate was formed. This experiment was repeated a number of times with the same result. In some cases the air and carbon-monoxide were drawn together slowly for a long time over the moist phosphorus, but this made no difference in the result. So frequently was the experiment performed, so great were the precautions against error, and so undeniably negative were the results, that, in spite of the explicit statements of Leeds and of Baumann, we do not hesitate to say that carbon-monoxide is not oxidized when exposed to the action of air and moist phosphorus. It follows, of course, from this, that the action of air and moist phosphorus on carbon-monoxide furnishes no evidence in favor of the view that there is an active condition of oxygen distinct from ozone."

The authors further say : "Leeds' error is easily explained. In the first place, he took no special precautions to protect the corks from the action of the ozone, and in the second place he passed the gases through a filter of moist cotton for the purpose of removing 'Oxides of phosphorus.' Now cotton, as it is usually met with, yields carbon-dioxide when subjected to the influence of ozone, so that the carbon-dioxide noticed by Leeds was probably the result of the action of ozone on the cotton or the oily substances which always adhere to it."

With regard to this explanation, it may be said that at a very early stage in experimenting with ozone, the observer is compelled to note the destructive action of ozone on corks and rubber connections, and either to eliminate them altogether or to boil the corks in paraffine and cover them with the same, both of which last precautions were taken in the present instance. The action of the very attenuated form of ozone obtained from phosphorus is excessively slight, as I knew when speaking of its employment in connecting ozone apparatus at an earlier date (J. Am. Chem. Soc. 11, 150) "Paraffine does not perfectly withstand the action of ozone, being slowly decomposed with the formation of carbonic acid. In the course of long continued use, the paraffine joints employed by the author in connecting the ozonizing elements of his large electrical ozonizer (ib. 1, 440) were destroyed, and had to be renewed from time to time. The amount of action on the joints was progressive, the paraffine connection between the first and second ozonizing element requiring to be changed very seldom, while that between the eleventh and twelfth elements needed frequent renewal." * * * *

"In experimenting with ozonized air, containing so small an amount of ozone as that employed in the investigation described in the present article" (ozonation by phosphorus), "the connections may be made of paraffine without entailing serious error, but in researches of greater nicety, where not merely the relative but the absolute amounts of ozone have to be determined, paraffine connections cannot be employed."

The cotton employed to remove the oxides of phosphorus, and I should have added in this as I have in other places, that cloud of vesiculated peroxide of hydrogen (the antozone of Schönbein and other authors) which by its passage through *water*, etc., without absorption, so puzzled earlier experimenters, this cotton, I repeat, was not the common cotton wool of commerce. It has been previously treated with alkali so as to remove all fatty matters, and then repeatedly exhausted with water and dilute acid, until its reaction was neutral, all soluble matters removed, and a white fibrous material as near pure cotton fiber as possible, had been obtained.

Still, in performing a crucial experiment, it was certainly important to eliminate every surface of contact except those of glass and water. Even mercury or any other possibly oxidizable metallic surface is objectionable, on account of a possible deozonation of the very minute amounts of ozonized air, which are formed by ozonation with phosphorus.

But before stating the details of this experiment, it will be well to narrate that performed by Baumann (Zeitsch. f. physiologische Chem. V, 250), who subsequently to my own labors effected the conversion of carbon monoxide to dioxide at ordinary temperatures by means of active oxygen.

He writes :—"A slow stream of air free from carbonic acid was conducted through a flask containing moist phosphorus ; thence into a second flask containing a mixture of 3 vols. oxygen and 1 vol. carbonic oxide, and finally through baryta water. The last remained perfectly clear after the gas had been passed through it for six hours, and after every trace of carbonic acid had been previously removed from the apparatus. On the other hand, when the mixture of carbonic oxide and oxygen was conducted into the flask containing phosphorus, and in which there must have been, according to our proposition, active oxygen, an altogether different result followed :—the baryta water presently became turbid and in an hour threw down an abundant precipitate of barium carbonate."

Commenting upon the above, our critics say :—"Nothing is said

about stoppers or rubber connections, and it is safe to assume that, in the apparatus used by Baumann, ozone came in contact at some points with organic matter. Hence the formation of carbon dioxide is easily accounted for." * * * * "Whatever the sources of error in Baumann's experiment may have been, we are confident that a repetition with the precautions taken by us will show him that his conclusion is wrong."

It is not our duty, but that of the writer impugned, to inform us whether this confidence in his having neglected to take the most obvious and indispensable precautions in the conduct of his experiments, is well founded.

My own repetition of the original investigation was performed as follows: —

Seven six-inch sticks of clean phosphorus were placed in a ten-liter flat-bottomed bottle, with an accurately fitting glass stopper, the bottle filled with air, and carbonic-acid-free, distilled water, and inverted in a small pneumatic trough, likewise filled with distilled water. Carbon monoxide, which had been made several days previously, and allowed to stand over distilled water in a glass gasholder, was purified by passing through a long train of purifiers similar to those employed in connection with carbon determinations in steel, and to which additional wash-bottles containing caustic potash and baryta water had been added. Whatever carbon dioxide was present originally, was so thoroughly removed that the baryta-water in the last wash-bottle remained absolutely limpid on passing sufficient carbonic oxide into the ozonator bottle to fill it nearly one-half. An equal quantity of air, after passage through the same train of purifiers, and equally well freed from the dioxide, was then introduced into the ozonator. While the bottle was still inverted in the trough, the tight fitting stopper was introduced, and it was then reverted, sufficient water being allowed to remain in the jar half to cover the phosphorus. The bottom of the bottle being flat, on distributing the sticks by gentle shaking, they were partly and uniformly submerged and exposed the largest possible amount of deoxidizing surface.

The ozonator still standing in the water of the trough, was then brought to a temperature of 24° C. by heating the trough, and kept at this temperature for six days. The antozone cloud (i. e. suspended hydrogen peroxide) produced the first day gradually subsided and the atmosphere became perfectly clear. The very gradual disappearance of these clouds, in part due to the gradual inter-

action of ozone and hydrogen peroxide with the formation of water and ordinary oxygen, and in part due to the mechanical difficulty with which the peroxide when once brought into a condition of aeriform and probably vesicular suspension goes into solution in water, strongly countenances the supposition that they are mainly and probably entirely, suspended hydrogen peroxide. The energy with which the oxides of phosphorus unite with and are absorbed by water, makes it an untenable supposition that they could, even if formed, remain for any length of time suspended in the atmosphere, so that whilst in my earlier experiments it seemed easier to suppose the clouds to be oxides of phosphorus than a non-volatile body like hydrogen peroxide in a state of aeriform suspension, yet later on the latter explanation was proved experimentally to be the correct one.

At the expiration of six days, the atmosphere contained in the bottle was withdrawn by the following manipulation, all contact with organic surfaces, except for a few seconds when the atmosphere remaining in the bottle came in contact with paraffine, being impossible.

The glass stopper was removed, a cork saturated with paraffine through which the necessary connecting tubes passed, inserted, and instantly the mouth of the bottle plunged beneath the surface of a mercury trough. This inversion carried the phosphorus and water down, so that the water covered the paraffined cork. Then the cork was quickly loosened and the aspirator being connected with the series of connecting tubes, but no air being allowed to enter, mercury was drawn up into the flask sufficient to cover the paraffined surface. The cork being forced back again, remained covered with mercury, during the remainder of the experiment.

The glass tubes were so bent, that no breaks or connections in them occurred between the atmosphere contained in the baryta water of the last wash-bottle through which the air was aspirated to take the place of the atmosphere contained in the ozonator, and the baryta water contained in the wash-bottle, through which the mixture of carbon oxides and air remaining at the close of the experiment, was finally passed. No break, except in the ozonator itself. And here it occurred above the surface of the water, the displacing air entering near the bottom, the gaseous products passing out from the upper portion of the jar. To prevent the diffusion backwards into the last wash-bottle of the entering current, of any of the atmosphere in the ozonator, a bulb was blown on one of the

lower curves of the entrance tube so as to form a mercury valve. Such a precaution was not necessary on the escaping tube, its end dipping directly beneath the surface of baryta water. This baryta water was again protected from the action of the atmosphere, by being connected with another wash-bottle containing neutral solution of potassium iodide. On now aspirating a current of air freed from carbonic acid through the apparatus, an abundant white precipitate formed in the collecting flask, and eventually a white crust formed on the sides of the entering tube beneath the surface of baryta water. When the atmosphere of the ozonator had been completely changed and no further precipitation occurred, the contents of the wash-bottle were transferred to a carbonic acid apparatus and the percentage estimated in the ordinary manner. The air used in aspirating, was freed from carbonic acid likewise. The weighings were as follows :

Potash bulbs after decomposition and aspirating.....	43.8295 grms.
Potash bulbs before decomposition and aspirating.....	43.8140 grms.
Increase in weight (Carbon Dioxide).....	0.0155 grms.

There is no difficulty in obtaining a qualitative test for carbon dioxide from the white crust adherent to the entrance tube, and the amount of which should properly form a part of the 15.5 mgrms. actually weighed. On cutting off this tube with its white crust, dropping it into a test tube and allowing a drop of acid to run down the crust, it was energetically decomposed with the formation of bubbles of gas, and a drop of lime water properly supported on the under side of a glass cover stopping the exit of the test tube, became turbid.

Objections to the fact of the above experiment being conclusive as to the production of 15.5 mgrms. and upwards of carbon dioxide.

1st. That there was an interval during which at the close of the experiment the atmosphere of the ozonator was in contact with the paraffine cork. Admitting that the air in this experiment was sufficiently charged with ozone to decompose paraffine, yet as a matter of fact at the close of the experiment no ozone was present. The potassium iodide in the final wash-bottle, after acidulation, contained no free iodine. And as it should properly be objected that this negative result is inconclusive, on account of the combination of nitrogen and ozone in presence of alkaline liquid to a nitrate, it

should also be remembered that this reaction would not have been sufficiently energetic to detain every trace of residual ozone.

In my earlier experiment, in which 5 liters of air had been used and the amount of carbon dioxide formed was 14 mgrms., the amount of residual ozone was only 0.04 mgrm.

2nd. The water contained sufficient ozone in solution to decompose the paraffine submerged beneath in the instant of time before being covered with mercury. This is eminently improbable, since the establishment of the fact that ozone is soluble at all, was a very laborious matter, and was only successful after many long continued qualitative tests made with very highly ozonized oxygen. (J. Amer. Chem. Soc. I, 220.)

The same remark applies to the possibility of the dissolved ozone being converted into ordinary oxygen in contact with the mercury covering the paraffined cork.

3rd. It may be said that even if we grant that carbon dioxide was formed, it might have resulted from the combined action of ozone and hydrogen peroxide, both of which oxidants were certainly present. But inasmuch as neither of these bodies alone effects the oxidation of carbon monoxide, (and Prof. Remsen's own experiments are conclusive as to this point), and inasmuch as their mutual action is not of an oxidizing but of a reducing character, both bodies being reduced, the one to oxygen, the other to water, the above supposition is untenable.

I hold, therefore, that the fact of the oxidation of carbon monoxide to dioxide by air over moist phosphorus, has been established by a rigid quantitative and qualitative analysis. Moreover, that this oxidation is, as I have always held it to be, the proof of the existence of active oxygen, as a body antecedent to the formation of ozone.

The essential feature in my own interpretation of the phenomena studied, is that active oxygen is always formed when reduction of the oxygen molecule occurs at temperatures compatible with the stability of the ozone molecule. That nascent hydrogen is not essential to this reduction is shown by the reduction being effected by phosphorus, in which case the intervention of nascent hydrogen does not occur. Hydrogen and phosphorus are probably only the two most conspicuous of the bodies capable of reducing the oxygen molecule at ordinary temperatures, and whilst both these are perissads and this fact appears to be connected with the production of active oxygen, I am not able in the present state of experimental

knowledge to say that the perissad nature of the reducing element is an essential feature of the formation of active oxygen. As I have repeatedly stated, the essential part of my hypothesis is the reduction of the oxygen molecule at a temperature compatible with the stability of the ozone molecule. Even without chemical intervention, the silent electrical discharge will do this, and form primarily active oxygen and secondarily ozone. That such is the case is shown by the formation of carbonic dioxide when a mixture of carbon monoxide and oxygen are submitted to the silent discharge.

ABSTRACTS.

Abstracts from the Journal of the *London Chemical Society*, by E. Waller, Ph. D.

On the Constitution of some Bromine-derivatives of Naphthalene. (Third notice.) R. Meldola (XLIII. p. 1.)

Description of the preparation of meta di brom naphthalene, Beta-di brom naphthalene, tri-brom naphthalene, and ortho-di brom naphthalene.

On the Constitution of Lophine. T. R. Japp. (XLIII. p. 9.) An argument against the view of Radziszewski, regarding the composition of the lophine molecule.

Contributions to the Chemistry of Lignification. C. F. F. Cross and E. J. Bevan. (XLIII. p. 18.)

The hypothesis of the authors previously adopted that *bastose* is a chemical whole in the sense of presenting a true combination rather than a mixture of cellulose with its own cellulosic constituent, has received further confirmation from their researches.

The close connection between these plant constituents and the trihydric phenols seems to be established.

A chlorinated derivative of bastose was obtained, which, though amorphous, was the same in composition when obtained from different sources, from jute, and from manilla. (*musa paradisiaca.*) The composition corresponded to the formula $C_{38}H_{44}Cl_{11}O_{16}$.

A note is appended remarking on the resemblance between the chloroderivatives from the alkaline liquors from Esparto boilers, and the halogen derivatives ef the sacchulmic compounds recently described by Sestini. (Gazetta 1882, 292).

On the Oxidation of Cellulose. C. F. Cross and E. J. Bevau. (XLIII. p. 22.) A compound to which the name *oxycellulose* has provisionally been given, has been found to be one of the products intermediate between cellulose and oxalic acid by the reaction of nitric acid (of 60 per cent.) on cellulose. The amount obtained was about 30 per cent. of the cellulose used. Oxycellulose prepared from different sources, and by different methods of purification, had a constitution indicating the formula C_{18} H_{26} O_{16} A nitro compound of this product was prepared, the examination of which by Eder's method (Ferrous sulphate) indicated the composition $C_{18}H_{28}$ $(NO_2)_8$ O_{16}.

The Analysis of Certain Plant Fibres. C. S. Webster. A table is given embodying the results of the examination of the fibro vascular bundles of several monocotyledonous plants and of the bast fibres of several decotyledonous plants. The reactions of these fibres with various reagents are also given. Also the ground upon which the several determinations included in the method of diagnosis employed, is based.

On a Condensation Product of Phenanthraquinone with Ethylic Aceto-acetate. F. R. Japp and F. W. Streatfield. (XLIII, p. 27.)

On mixing 100 grms. of phenanthraquinone with 90 grms. ethylic aceto acetate, and then adding 150 c c of dilute KHO (1:6) and warming gently with agitation, ethylic-phenanthraoxylene-aceto acetate is formed. The compound was purified by boiling with alcohol, washing with water, and finally recrystallizing two or three times from boiling benzene. It is deposited in tufts of fine white silky needles. Fuses with blackening and evolution of gas at 184.°5C. Soluble in alcoholic and acetic acid. By oxidation with chromic acid it yields phenanthraquinone.

Composition, C_{20} H_{16} O_4.

	Calculated	Mean of 3 Analyses
C	75.	74.93
H	5.	5.06
O	20.	

Mixed with amorphous phosphorus and fuming hydriodic acid and heated, a compound $C_{20}H_{18}C_4$ was obtained.

Dissolved in KHO, a new dibasic acid, $C_{18}H_{14}O_4$ was precipitated by addition of HCl. The silver and barium salts of this acid, were isolated and analyzed. These results appear to afford a strong argument in favor of Fittig's formula for phenanthraquinone as against that of Graebe.

Note on the Preparation of Diphenylene-Ketone Oxide. W. H. PERKIN. (XLIII, p. 35.) On heating salicylic acid with acetic anhydride, and then distilling off the acetic acid and excess of acetic anhydride, a mass was obtained which, by distillation, afforded an oily product, solidifying in the neck of the retort. On washing and purifying by recrystallization from alcohol, pale yellow needles (not, as had been anticipated of salicylic anhydride,) but of diphenylene-ketone oxide $C_{13}H_8O_2$, were obtained.

	Calculated.	Found.	
C.....	79.59	79.41	79.45
H.....	4.08	4.37	4.17

On Certain Brominated Carbon Compounds Obtained in the Manufacture of Bromine. S. DYSON. (XLIII, p. 36.) In a liquor obtained as a by-product at the works of the North British Chemical Company, chlorobromoform, as well as carbon tetrabromide and bromoform were found. The presence of the first has not before been noted.

On Ethylene Chlorobromide, and some Compounds Obtained from it. J. W. JAMES. (XLIII, p. 37.) A summary of the principal results is given as follows :

1. In preparing ethylene chlorobromide, by passing the gas into a solution of Cl Br., it is necessary, in order to obtain a pure product and good percentage, that the chlorine be passed into the bromine at a temperature of about 0°, otherwise a substance is formed boiling some 3 to 4° higher than pure C_2H_4 Cl. Br., which is useless for the advantageous preparation of ethylene chlorothiocyanate.

2. If an aqueous solution of neutral sodium sulphite and ethylene chlorothiocyanate be brought together in direct sunlight, the sodium salt of a new acid, viz., ethylene-thiocyansulphuric acid, $C_2H_4\begin{cases}SO_3H\\SCN\end{cases}$ appears to be produced.

3. By passing ammonia into an ethereal solution of chlorethyl

sulphonic chloride, no amide is formed; with ethyl sulphonic chloride, however, the corresponding amide is easily obtained.

4. By the action of neutral sodium, sulphite in aqueous solution upon ethylene dibromide or chlorobromide, isethionate of sodium is apparently produced, with evolution of SO_2, in addition to the well-known ethylene-disulphonate of sodium obtained by Strecker.

On the Condensation Products of Oenanthaldehyde. Part I. and II. W. H. Perkin, Jr. (XLIII, p. 45.) A review of the most important researches on this subject is first given. The principal products of the action of KHO on œnanthaldehyde are heptoic acid, the acid $C_{14}H_{26}O_2$, and the aldehydes $C_{14}H_{26}O$ and $C_{28}H_{50}O$.

The products of the action of KHO, of nascent hydrogen, &c., upon these derivatives and upon œnanthaldehyde are described. At the end of the paper a table of the different derivatives is given, as follows:

Formula.	Boiling Point.	Sp. Gr. at 15°.
Œnanthaldehyde,	153–154°	0.8231
$C_{14}H_{26}O$,	277–279°	0.8494
$C_{13}H_{27}COH$,	266–268°	....
	(m. p. 29.05)	
$C_{13}H_{25}CH_2OH$,	280–283°	0.8520
$C_{13}H_{27}CH_2OH$,	270–275°	0.8368
$C_{13}H_{25}CH_2OC_2H_3O$,	285–290°	0.8680
$C_{13}H_{27}CH_2OC_2H_3O$,	275–280°	0.8559
$C_{13}H_{25}COOH$,	275–285°	....
	(at 250 min.)	
$C_{13}H_{27}COOH$,	300–310°	....
$C_{21}H_{40}O$,	310–315°	0.8744
	(at 300 min.)	
$C_{28}H_{50}O$,	330–340°	0.8831
	(at 200 min.)	
$C_{28}H_{54}O_2$,	330–340°	....
	(at 200 min.)	
$C_{28}H_{56}O_4$,	melts at 52–53°	....
$C_{21}H_{44}O_2$,	397–300°	....

The Sp. Gr. at 30° and at 35° are also given.

On the Condensation Products of Isobutaldehyde, Obtained by Means of Alcoholic Potash. W. H. Perkin, Jr. (XLIII, p. 90). The products obtained were as follows:

Formulæ.	Boiling Point.	Remarks.
$C_{12}H_{22}O_2$	154–157°	Condensation products.
$C_{16}H_{30}O_2$ (?)	190–200°	
$C_{20}H_{38}O_4$	223–225°	
$C_{24}H_{44}O_4$	250–255°	
$C_{28}H_{48}O_3$	227–229°	
	(100 mm. pressure).	
$C_{12}H_{26}O_2$	170–175°	Alcohol (and acetate) produced by the action of nascent hydrogen on $C_{12}H_{22}O_2$.
$C_{12}H_{24}O_2(C_2H_3O)_2$	185–190°	
$C_{20}H_{37}O_4(C_2H_3O)$	240–242°	Acetates produced by the action of acetic anhydride on $C_{20}H_{38}O_4$.
$C_{20}H_{36}O_4(C_2H_3O)_2$	248–252°	
$C_{20}H_{42}O_4$	217–223°	Produced by saponifying $C_{20}H_{36}O_4(C_2H_3O)_2$.
$C_{12}H_{22}O_3$	245–255°	Acid produced by the action of potash on isobutaldehyde.

The Alkaloids of Nux Vomica. No. II—**On Brucine.** W. A. Shenstone. (XLIII, p. 101.) The results show that there is reason to think that brucine is a dimethoxyl derivative of strychnine. Brucine, heated with hydrochloric acid, gave amounts of methyl chloride varying from 64.6 cc. to 90.2 cc. methyl chloride per gramme of brucine. Prolonged heating at low temperatures gave the highest results. Dimethoxy strychnine would yield theoretically 113 cc.

The Behavior of the Nitrogen of Coal during Destructive Distillation: with some Observations on the Estimation of Nitrogen in Coal and Coke. W. Foster. (XLIII, p. 105.) Experiments were made on a coal containing 1.73 per cent. of nitrogen. The most satisfactory results were obtained by combustion with copper oxide in vacuo. In this case it was found advantageous to place the tube in an outer tube of wrought iron, just sufficiently wide and long enough to encircle the whole length of the highly heated part. Wide tubes with large quantities of copper oxide were found to serve best. Of 100 parts of the nitrogen in the coal, it was found that the distribution was as follows :

Nitrogen of coal evolved as ammonia	14.50
" " " cyanogen	1.56
" " present in the coal gas in the elementary condition	35.26
Nitrogen remaining behind in the coke	48.68
	100.

Preliminary note on some Diazo derivatives of nitro-benzyl cyanide. W. H. PERKIN. (XLIII, p. 111.)

By adding an aqueous solution of diazo benzene chloride to an alcoholic solution of nitro-benzyl cynanide freshly mixed with alcoholic potash, until the color became yellowish, a brown precipitate was obtained, which on filtering and purifying by re-crystallization from alcohol and acetic acid, proved to be $C_{14}\ H_{10}\ N_4\ O_2$. The alcoholic solution gives a violet color with alkalies, which disappears with acids.

It fuses at 201-202°. A second body fusing at 45°C, probably orthonitro benzyl chloride was also obtained iu preparing the nitro-benzyl cyanide. The investigation is still in progress.

Researches on the Induline Group. Part I.—O. N. Witt and E. G. P. THOMAS. (XLIII, p. 112.)

The "indulines" are defined as those colored compounds formed by the action of amidazo compounds upon the hydrochlorides of aromatic amines, with elimination of ammonia.

In studying the action of amidazobenzene on aniline hydrochloide, the re-action has been found to afford several different coloring matters varying in quantities and properties, according to the temperatures at which the process may be conducted, and the manner of it. The following compounds were obtained:

Designation.	Formula.	Remarks.
Azophenine,	$C_{36}\ H_{29}\ N_5$, melts at 236-237°	Identical with [Kunich's Azophenine.
Induline, 3 B,	$C_{30}\ H_{23}\ N_5\ HCl$,	Sky Blue color.
Induline, 6 B,	$C_{36}\ H_{27}\ N_5\ HCl$,	Dark-bluish purple.

The bases were also separated from these hydrochlorides, and analyzed. The researches on this subject are as yet uncompleted.

On a New Method of Estimating the Halogens in Volatile Organic Compounds. R. T. PLIMPTON and E. E. GRAVES. (XLIII, p. 119.)

The appparatus is so arranged that a stream of illuminating gas and air, mixed as in the Bunsen burner, passes over the volatile compound, taking up its vapors. The mixture is then burned under a trumpet tube, similar to that used in the Letheby apparatus for sulphur determinations in gas.

The products of combustion are drawn through U tubes, fitted with glass beads, moistened with caustic soda solution, and finally through a solution of silver nitrate, which acts as a guide to the completeness of absorption. Several analyses are quoted showing the accuracy attainable.

A Modified Liebig's Condenser. W. A. SHENSTONE. (XLIII, 123.)

The condenser is set vertically; just below the water jacket, an annular ledge of glass is placed inside the condensing tube, to catch the condensed liquid as it runs down the sides. This space is connected with a tube extending laterally to carry off the products of condensation. A reference to the accompanying cut is necessary for a complete understanding of the operation of the apparatus.

On some Fluorine Compounds of Uranium. A. SMITHELLS. (XLIII, p. 125.) By the action of HF on U_3O_8 a green powder and a yellow solution are obtained. According to Ditte, hydrogen is given off in the process. The author was unable to obtain any. The green powder is stated by Ditte to be UO_2F_2, by Bolton to be UF_4. The examination showed Bolton to be correct. This powder, by heating affords a white crystalline sublimate—Alpha Uranium oxyfluoride. UO_2F_2.

The yellow solution was found to contain Beta Uranium oxyfluoride. On fusing U_3O_8 with alkaline fluorides, compounds containing apparently alkaline uranates, but no fluorine except as impurity, were obtained. U_3O_8 fused with K F H F, afforded UO_2FF_2 K F. The results all through are altogether at variance with the conclusions of Ditte.

On the Volume Alteration Attending the Mixtures of Salt Solutions. W. W. J. NICOL. (XLIII. 135.)

The conclusions are: 1. When two salt solutions which cannot experience double decomposition, are mixed, a change of volume takes place due to the different affinities of the salts for water.

2. That double decomposition takes place in solution, and that the volume change is an index, and even a measure of this.

Two New Aluminous Mineral Species, Evigtokite and Liskeardite. W. FLIGHT. (XLIII. p. 140).

The Evigtokite from the Greenland cryolite beds, was in white transparent crystals, quite soft. It contained

Al	16.23
Ca	22.39
Na	0.43
H_2O	5.71

Indicating the formula, Al_2F_6. 2 Ca F 2 H_2O.

The Liskeardite from Cornwall, first described by Mr. R. Talling, in 1874, contained :

Fe_2O_3	7.640		
Al_2O_3	28.229		
As_2O_5	26.962		
SO_3	1.111		
CuO	1.027		
CaO	0.719		
H_2O at ordinary temp.	4.351		
" at 100°	10.962	$6H_2O$	
" at 120°	5.551	$3H_2O$	34.053
" at 140–190°	8.220	$7H_2O$	
" with PbO	4.969		
	99.741		

The formula is put as $R'''AsO_4$. $8H_2O$.

On the Absorption of Weak Reagents by Cotton, Silk and Wool. By E. J. Mills and J. Takimine. (XLIII. p. 142.)

The absorption of H_2SO_4 HCl and NaHO were tried upon these different textures. The ratio of absorption for cotton and silk are:

	Cotton.		Silk.
H_2SO_4	1	:	2.6
H Cl	1	:	2.2
NaHO	1	:	2.3

Wool and silk resemble one another with NaHO but with the acids the wool takes up much more.

The resemblance between silk and cotton with these reagents is most marked, probably indicating a similarity in chemical composition between the two.

On the Action of Chlorine on Certain Metals. R. Cowper. (XLIII, p. 153.) With perfectly dry chlorine gas no action was observed on Dutch metal, Zinc, Magnesium, and Sodium.

Very slow action on Silver and Bismuth.

Rapid action on Tin, Arsenic, Antimony and Mercury.

With Potassium the action was very slow, a rich purple colored compound forming; by heating to fusion the action was accelerated, but the metal did not take fire until heated considerably above the fusing point. Very minute quantities of water determined the attack of almost all the above metals by the chlorine.

Some Notes on Hydrated Ferric Oxide, and its Behavior with Hydrogen Sulphide. L. T. Wright. XLIII. p. 156.

It was found impossible to obtain absolutely pure ferric hydrate by precipitating ferric chloride with ammonia, some basic chloride always remaining in the precipitate.

Freshly precipitated ferric hydrate suspended in water on being saturated with hydrogen sulphide, turned black and then dissolved in potassium cyanide, the reaction being:

$$FeS+6KCN=K_2S+K_4Fe(CN)_6$$

After washing and drying at 100°C. it did not exhibit the same phenomena.

Ferric hydrate boiled with H_2S afforded some ferrous sulphate. Free sulphur always resulted from this reaction, when conducted in such a way as to imitate the action going on in gas purifiers. It appeared that 17 to 30 per cent. reacted thus: $Fe_2O_3,H_2O+3H_2S=2FeS+S+4H_2O$ and the remainder thus: $Fe_2O_3,H_2O+3H_2S=Fe_2S_3+4H_2O$.

Note on some Derivatives of Fluorene $C_{13}H_{10}$. W. R. Hodgkinson and F. E. Matthews. (XLIII, p. 163) The compound used as a standing point was ortho fluorene, $C_{13}H_{10}$ melting at 113°.

The main object was the preparation of fluorol $C_{13}H_{10}O$. The compounds made were: alpha dibromfluorene melting at 165° $C_{13}H_8Br$. Monobromfluorence $C_{13}H_9Br$. melting at 101–102°. Dibromodephenylene ketone $C_{13}H_6Br_2O$, melting at 198°. Bromdipheylene ketone, $C_{13}H_7BrO$, melting at 104°. The sulphonic acid, $C_{12}H_9SO_3H$. The barium salt of this acid containing $2H_2O$, and the cadmium salt containing $6H_2O$ were analyzed.

On fusing the potassium sulphate with potash instead of fluorol, trihydroxyphenol $C_{12}H_{10}O_3$ (melting at 204–205°) and dihydroxyphenol $C_{12}H_{10}O_2$ (melting at 98°) were obtained, the methylene group having been split off.

Alpha dichlorofluorene $C_{13}H_8Cl_2$ melting at 128° and its corresponding ketone melting at 158° were also obtained, as well as $C_{13}H_3Cl_7$ melting at 104°. Alcoholic potash reacted with this last compound affording a red body of the formula $C_{13}H_5Cl_5$.

The sulphonic acid corresponding to the alpha dibromofluorine were prepared (melting at 142°) and the barium salt $(C_{13}H_7Br_2SO_3)_2$ Ba was analyzed.

On alpha-ethyl-valero lactone, alpha-ethyl-beta-methyl-valero lactone, and on a Remarkable Decomposition of beta-ethyl-aceto-succinic ether. S. Young. (XLIII, p. 172).

On the Constitution of Molecular Compounds. The Molecular Weight of basic Ferric Sulphate. S. U. Pickering (XLIII., p. 182). The experiments were conducted by means of ascertaining the unit of water removable. The choice was between the formula $2Fe_2O_3SO_3$ (molecular weight 400) and $Fe_2(SO_4)_3$, $5Fe_2O_3$, (molecular weight 1200.) The results indicate that the latter formula $Fe_2(SO_4)_3$, $5Fe_2O_3$, xH_2O) is most probably correct.

The Phenates of Amido Bases. R. S. Dale and C. Schorlemmer. (Vol. XLIII., p. 185.) Red aurin was found to be nothing but aurin containing pararosanilin.

On dissolving equal molecules of aurin and rosanilin in alcohol, and evaporating rosanilin aurinate was found to remain. Anilin phenate $C_6H_7N.C_6H_6O$ was obtained, fusing at 29.5° and boiling at 184.5° (uncorr.) This salt was found to be a powerful antiseptic. From an alkaline solution of aurin which, though originally red, had turned brown, the addition of an acid caused the separation of di-oxy-phenyl-ketone $CO(C_6H_4OH.)_2$

On some Derivatives of Diphenyl Ketone Oxide. A. G. Perkin. (Vol. XLIII., p. 187.) A by-product in the preparation of this oxide (by distilling a mixture of salicylic acid and acetic anhydride) was found to be a compound $C_{14}H_8O_3$, fusing at 192° and distilling with partial decomposition. This compound, boiled with alcoholic potash, afforded an acid $C_{14}H_8O_4$. Both this acid and its silver salt were analyzed. The acid fused at 275°.

Diphenyl ketone oxide treated with nitric acid (Gr. 1.45) and a little sulphuric, yielded the di-nitro compound, $C_{13}H_6(NO_2)_2O_2$ crystallizing in satiny needles having electrical properties and fusing at 262°. Tin and hydrochloric acid afford with this compound the corresponding diamido-phenylene ketone oxide $C_{13}H_6(NH_2)_2O_2$ forming orange to ruby colored needles. Both of these last compounds affect polarized light.

Nordhausen sulphuric acid heated with the oxide, on dilution, neutralizing with $BaCO_3$ &c., afforded the barium disulphonate $C_{13}H_6O_2Ba(SO_3)_2$ moderately soluble in boiling water, and quite stable even at 200°.

Bromine with the oxide afforded $C_{13}H_6O_2Br_2$ forming transparent needles fusing at 210°, and subliming a few degrees higher.

Chemico-Microscopical Researches on the Cell-contents of Certain Plants. A. B. GRIFFITHS. (Vol. XLIII., p. 195.) Savoy cabbages grown in a soil to which no iron compounds were added, were less healthy than those grown in a soil to which ferrous sulphate had been added. The ashes of the plants also showed more iron where it had been added to the soil, and in all cases crystals of ferrous sulphate were found by the microscope in the cells of the plants.

On Condensations of Compounds which Contain the Di-carbonyl Group with Aldehydes and Ammonia. F. R. JAPP. (Vol. XLIII., p. 197.) Controversial.

On some Condensation-Products of Aldehydes with Aceto-Acetic Ether and Substituted Aceto-Acetic Ethers. F. E. MATTHEWS. (Vol. XLIII., p. 200.)

The results given are those from an examination of,

1. The condensations of aceto-acetic ether with isobutylicaldehyde, valeric aldehyde, chloral, furfural, and acrolein. The relations of di-substituted aceto-acetic ethers to benzoic aldehyde. 2. Benzoic aldehyde with aceto diethyl acetic ether, aceto dichloracetic ether, and aceto benzliden acetic ether. Also, 3. Benzoic aldehyde with aceto-monoethyl acetic ether. The condensation takes place only in the methylene group, quite readily in the case of aceto-acetic ether, but with more difficulty with the mono and di-substitution products of that ether.

Contribution to the Chemistry of "Fairy Rings." J. B. LAWES, J. H. GILBERT and R. WARRINGTON. (Vol. XLIII., p. 208.)

The "fairy rings" are rings of grass, growing more luxuriantly than that in the immediate neighborhood, the ground within the ring sometimes appearing almost barren. A growth of fungi is usually observable around the outside of these rings, which increase perceptibly in size from year to year.

The theory has been advanced that the fungi assimilate nitrogen from the air, and by their death and decay, render this nitrogen assimilable by the grass. The examination of the soil within, on, and outside of the ring, shows that, though poor in nitrogen within the ring, the soil is somewhat richer in nitrogen outside of it than on the ring. The conclusion is, that the fungi have the power of assimilating the organic nitrogen of the soil to a greater extent than the grass, and that the atmospheric nitrogen has no essential connection with the phenomenon.

The report of the Anniversary Meeting of the Chemical Society, held March 30th, 1883, is here inserted p. 224.

PROCEEDINGS OF THE AMERICAN CHEMICAL SOCIETY.

Regular Meeting, June 1, 1883.

President JAMES C. BOOTH occupied the chair.

The minutes of the May meeting were read and approved.

The following gentlemen were then unanimously elected regular members of the Society:

ADOLPH HOEGLER.
Prof. P. W. BEDFORD.
WILLIS G. TUCKER, M. D.
LEWIS GORDON PAUL, D. Sc.
THOS. RADCLIFFE.

The following gentlemen were then proposed for membership:

Philip S. Barker, by E. Waller, C. F. Chandler, T. S. Gladding.

C. F. McKenna, by E. Waller, A. H. Elliot, L. Pitkin.

The following papers were then read:

I. On the Nascency of Oxygen, by Dr. A. R. Leeds.

2. On Determining the Rotation of Left-handed Solutions with the German (Scheibler-Vectzke Soleil) Instrument, by George S. Eyster, Ph. D.

3. Some Notes on the Ammonia Process for Water Analysis (illustrated by the pump-well waters of Brooklyn and New York Cities), by Nelson H. Darton.

Remarks on the first paper were made by Prof. Benneman.

The third paper drew forth from Dr. Booth an earnest expression as to the importance of water analysis.

A discussion as to the influence of the depths of Brooklyn wells on their character, then followed, and was participated in by Messrs. Booth, Bartley, of the Health Board of Brooklyn; Pitkin, Alsberg, and others. The methods of analysis were also discussed by Messrs. Darton, Doremus, Waldstein, and others.

The Society unanimously ratified the choice of Martin E. Waldstein, by the Committee on Publications, to supply the place of L. H. Friedburg,

Some excellent micro-photographs of elephants' milk and cream were exhibited before the Society by Dr. Stratford.

Dr. Booth was requested, by vote of the Society, to correspond with the committee of the German Chemical Society, to see what steps might be taken in regard to the Wöhler testimonial.

The Society then adjourned.

THOS. S. GLADDING,
Recording Secretary.

ON DETERMINING THE ROTATION OF LEFT-HANDED SOLUTIONS WITH THE GERMAN (*Scheibler-Ventzke-Soleil*) INSTRUMENT.

By Geo. S. Eyster, Ph. D.

The following plan for determining negative rotation, in the absence of an instrument graduated for left-handed solutions, occurred to me some time ago. Though seeming quite obvious, I have not seen it in print.

If we use a + quartz plate reading n degrees to the right (either used instead of one of the cover-glasses, or sunk in an outside recess of one of the brass caps, and secured in place by a thin metal ring and three screws) in connection with a — solution of less rotating power the reading will be N or n-x = N = —x = (N-n) where —x = the rotating power of the solution in degrees of the instrument. For instance:

The reading of the quartz plate is 90°.

The reading of the plate and solution is 66°, then — x = 66° — 90 = —24°.

Or in other words, the solution has lowered the reading from 90° to 66°; hence is left-handed and is equal in value to the difference between 90° and 66°.

It is best to use a plate reading from 80° to 100° rather than one of much less thickness, as apart from the facility it affords for using a double normal solution for inversion, the value and equality of that portion of the scale is better under control.

I have not had a good opportunity to test the method since it occurred to me, but its success, as one acquainted with the principle of the quartz compensator will readily see, is merely a matter of detail.

NOTES ON THE AMMONIA PROCESS FOR WATER ANALYSIS (ILLUSTRATED BY THE PUMP-WELL WATERS OF BROOKLYN AND NEW YORK CITIES.)

By Nelson H. Darton.

It is with hesitation that I add to the now almost too voluminous literature of water analysis. The investigations of which I wish to give results have revealed however considerable matter of interest, especially in regard to the volatile nitrogenous matters which for some time have been known to be a con-

stituent of polluted potable waters. Remsen, in his report on Boston water, in 1881, called attention to them more definitely, and Marsh quite recently has shown their influence on the results obtained in the analysis of even slightly contaminated waters.

The importance of recognition of these volatile constituents which are generally lost sight of in the ordinary method of analysis, as they pass over with the free ammonia but do not affect the Nessler reagent is, however, as yet undetermined, and by investigations of its physiological action in the concentrated state upon rabbits I have been enabled to draw conclusions which I trust will not be without value in judging the character of a potable water, as the sequel will show.

It was also very desirable to investigate its association with the other ingredients generally present in contaminated waters ; to what extent these relations change by allowing the waters to stand, and of the microscopic growths present in the waters examined ; consequently the research was extended to include all these data as completely as the facilities in my laboratory would allow, and are given in the tables.

The waters selected for the investigations were known to be polluted with sewage and decomposing vegetable matter, and highly charged with these volatile nitrogenous matters of which I wished more particularly to investigate the characteristics. These were the well waters of Brooklyn, more familiarly known as "pump waters." There are about three hundred of these wells and their pumps, most of them less than a hundred feet in depth, that yield a plentiful supply of cool, clear water even in the dry seasons. The sources of supply of these wells, or in other terms their water-sheds, are almost exclusively from water infiltering through the cobble-paved streets and backyards of houses, then through gravel and sand, finally collecting in impervious depressions, generally of clay, underlying the city. The area drained to each pump is quite extensive, as Brooklyn is built upon the slopes of numerous hills. So far as I can find, there was no system followed in locating the pumps ; they are more abundant in the lower and older wards of the city, now populated by the poorer classes, and having with few exceptions the highest death rates of any portion.

The sources of pollution of these waters are numerous. The principal one is by infiltration—first through the filthy streets, covered with animal excreta and decomposing vegetable matter, then through the soil and subsoil, saturated with accumulated decayed and slowly

putrefying matter, whose only source of elimination is by these waters—much of this finds its way to the sea, but no small proportion of it is raised in the pumps. Another source of pollution which I am led to believe is a very considerable one, is from the loosely built sewers and carelessly-joined drainage pipes from the houses. Then, again, from the loosely-floored stables, manure pits, corner cesspools and closets in many of the backyards a great amount of sewage drains into the ground and adds to the pollution. There is naturally little or no opportunity for purification of these waters by aëration.

Three of the few remaining pumps in New York city were included in the investigation for comparison. These wells are similarly polluted to those of Brooklyn.

Thirteen wells were indiscriminately selected, numbered in the table from Nos. 75 to 88, and including the three New York City wells.

The analyses were made at three intervals, first on the same day that they were drawn; second, after standing forty-eight hours, and third, after six days. During these intervals they were kept in bottles but half-filled and loosely stoppered.

The results were obtained as follows:

Residue.—50 cc. evaporated, dried for three hours at 100° and weighed.

Loss on ignition.—The above residue was ignited for twenty minutes, cooled and weighed. Carbonic acid water was not added.

Chlorine—Titration on 50 cc.

Nitrites.—According to Preusse and Tiemann's description of the application of Griess' test (metadiamido benzol.)

In these and other colorimetric examination the colors obtained were compared with those produced in solutions of known strength of the constituent sought.

Nitrates.—By the zinc-copper-couple as described by Thorpe.

Oxygen required.—By the moist combustion method of Wauklyn half the quantities prescribed by him being taken.

Ammonia, free and albuminoid, by Wanklyn's method. To obtain permanganate solution free from ammonia the following process was followed: Freshly fused potassa was allowed to cool out of contact with the air in an exhausted bell glass; this and the proper amount of permanganate were dissolved in sufficient absolutely ammonia free water, readily obtained by redistilling Ridgewood water with the proper precautions. The solution thus made

was boiled in a distilling flask with a mark on its neck whereunto it held half a litre of water at 100° c.; it was connected with a condenser, and when 10 cc. of distillate was found to be free from ammonia, the flask was filled with pure boiling water and poured into thoroughly cleansed, small hot bottles of about 100 cc. capacity, for which it was used. Frequent tests of this method revealed not even a trace of ammonia, even when distilling from a half litre and collecting the first 10 cc. of distillate.

For measuring this solution a pipett of the form that I proposed before the Society some time ago* but with a three foot length of rubber tubing and two strong pinchcocks. Upon it were two marks, one at 10 cc. capacity, the other on the stem at 1 cc.

In every instance 100 cc. of the water was taken and the distillation conducted in 250 cc. in distilling flasks of German glass.

Precautions were taken against the disturbing influence of ammonia in the air of the laboratory by placing dishes of dilute hydrochloric acid in the niche which was devoted exclusively to the water analyses. This did not, however, appear to be necessary.

In the estimation of the volatile nitrogenous matters 100 cc. of the water were diluted, and every 10cc. of distillate diluted to 20 cc. and then divided into two portions, one of which was Nesslerized directly and confirmed the free ammonia found in the first distillation, and the remaining portion placed in a 35 cc. distilling flask joined to a miniature but effective condenser, some water and 1 cc. of the permanganate mixture added and redistilled—the 1st 10 cc. of distillate always contained all the NH_3 and was Nesslerized, the difference between this and the first result being equivalent to the ammonia from the volatile nitrogenous matters. In order to determine some of its characteristics, if possible, all the waters examined were concentrated from five litres to 50 cc. This we readily accomplished by distilling at first in half litres and collecting each first 100 cc. distillate, these were mixed and the litre obtained distilled in two portions, each first 100 cc. of distillate being likewise collected ; to this a calculated amount ofphosphoric acid was added to hold back the free ammonia, 50 cc. was then distilled off and after redistillation was found to be quite free from ammonia. After filtration through asbestos felting 1 cc. distilled with sufficient permanganate mixture and the ammonia Nesslerized, showed that about

* This journal, III.—12.

two-thirds of the NH_3 of the volatile nitrogenous matter had been secured and all other bodies, both chemical and organized, had been left behind.

A number of fine young rabbits were selected and sufficient amounts of these concentrations were injected under their skin with the effects detailed after each table. This it was expected would confirm a suspicion that I had long entertained that these matters were deleterious to the animal economy, and is, I think, fully justified by the results obtained.

Microscopic examinations were made of the sediments from the waters which were generally very slight; and the various forms of life found, so far as I could identify them, are detailed after the tables. In order to separate and examine the Bacilli, Micrococci and similar organisms, two methods of separation or rather concentration were tried, the first by adding osmic acid and allowing that which had been killed by its action to deposit; and the other by developing in a film of gelatine; both of these methods were found to yield quite satisfactory results, but preference was given to the latter on account of its larger yield. Before covering with the film a small amount of Cohn's developing liquor was added to the water. The dissolved gases were determined by the usual method of distillation and absorption by potash and pyrogallate of potassa. It may be well here to recall the significance of the relations of the proportions of the gases dissolved in water and their change upon standing. Water, under the most favorable conditions of purity and at 15° c., will dissolve 6.3 cc. of oxygen and 11.7 cc. of nitrogen, and the relation is only disturbed to any great extent by putrefaction of matter held in solution and also by the action of femrents.

At about the time that the research was commenced Dr. A. R. Leeds in a preliminary, and as yet unpublished communication to the N. Y. Academy of Sciences, called attention to a new actinic method for determining putrescible organic matter in potable waters, which, in a number of trials he had found to yield extremely satisfactory results. Consequently it was thought desirable to include an investigation of the value of this new method

The details of the process were orally communicated to me, and were quite closely followed. One hundred cc. of the water is mixed with the same amount of decimonnal silver solution preferable the nitrate; the mixture in a closed bottle is exposed to light as long as it is acted upon, and the decomposition has been completed, the putrescible organic matter having been oxidized at the expense

of the silver, which precipitates as metal. All is then poured through a Gooch filter, and this and the bottle washed with ammonia to dissolve haloid salts. The silver adhering to the inside of the bottle and that on the filter is then dissolved in nitric acid and determined as may be convenient; its weight in millegrammes multiplied by 10 equal parts per million, and by the ratio of 108:16 equal oxygen required.

This process has so far yielded the most satisfactory of results, and promises to be a convenient, applicable and accurate method for the analysis of potable waters, if not alone, at least with the ammonia process, and when appreciable amounts of sulphides are absent.

The location of the wells and results of the physical and physiological examinations of the waters were as follows: The effects on rabbits here spoken of are the effects produced by the subcutaneous injection of a small portion of the concentrated nitrogenous matter obtained as described.

No. 75. Corner of Johnson and Lawrence streets.

Appearance in 2 ft. tube, bright and clear. Sediment slight. Microscopical examination of sediment: Sand, fibrous vegetable matter, a cypris, diatoms, and a few yellow algae.

The concentrated volatile nitrogenous matter injected under the skin of a rabbit caused violent diarrhœa, with vomiting and death in about an hour.

No. 76. Near corner Myrtle avenue and Lawrence street.

Bright and clear. Sediment considerable, containing much sand, also, *confervae*, *desmids*, *oscillatorae*, *palmaceae*, and *volvox*, two varieties of *amoeba* a *chilodon*, an *auginuillata fluviatalis* and numerous diatoms.

The effect of the concentrated nitrogenous matter on a rabbit was essentially the same as with No. 75, but more intense.

No. 77. Corner of Bridge and Tillary streets.

Bright and clear. Sediment small, containing sand, fibrous vegetable matter, some diatoms and a few dead *chaetonotii*. Injection of the nitrogenous matter under the skin of a rabbit produced a slight transitory diarrhœa.

No. 78. Corner Sumner avenue and Bainbridge street.

Strong odor of brewery swill, develops that of H_2S on standing. Sediment abundant, dark colored, containing numerous algae and animalculæ. The effect on a rabbit was to produce diarrhœa,

cramps, vomiting and death. A similar effect, though not so rapidly fatal, was produced on a cat.

No. 79. Corner Johnson and Bridge streets.

Water clear and bright. Sediment small and containing scarcely anything worthy of mention. Effect on a rabbit similar to that of the previous one.

No. 80. Corner Chapel Place and Bridge street.

140 feet deep. No sediment. Effect on a rabbit slight transitory diarrhœa.

No. 81. Near corner of Irving Place and Fulton avenue.

Clear and bright. Sediment slight, consisting of sand, *diatoms*, *algae*, several *cypri*, *chilodons* and *amœbæ*. Effect on a rabbit, violent diarrhœa followed by slow recovery.

No. 82. Corner Bridge and Nassau streets.

Water clear. Sediment large, containing sand, algae and monads. The bacteria obtained by filming when injected under the skin of a rabbit caused diarrhœa and death. The same effect was produced by the concentrated nitrogenous matter.

No. 83. Corner Fulton avenue and Carleton.

Water clear. Sediment inconsiderable. In this water the proportion of total ammonia was much less than the sum of the five and albuminoid together. It probably contained some substances oxidized by the permanganate to nitrates. The tests were duplicated with the same results.

No. 84. Corner Duffield and Johnson streets.

Water clear. Sediment moderate, containing sand, numerous *diatoms*, *chilodons*, etc. Effect on a rabbit, violent diarrhœa, etc. Death in two days.

Some of this concentrated nitrogenous matter was also injected under my own skin. The effects were similar. Diarrhœa was produced in two hours, and continued for two days.

No. 85. Hanover Place near Fulton street.

Water clear. No perceptible sediment. Effect on a rabbit, intermittent diarrhœa lasting for about a week. The effect on my assistant was to produce a tendency to diarrhœa lasting four days.

No. 86. New York City, corner Thames and Church streets.

Water clear. Slight odor of acetylene, which soon disappeared. Contained no volatile nitrogenous matter. Effects on a rabbit nil.

No. 87. New York City, corner Dey and Greenwich streets.

Water clear. Much sediment. Both the sediment and the volatile nitrogenous matter produced violent diarrhœa, and vomiting,

with rabbits, which in the case of the sediment terminated in death.

No. 88. Corner Church and Cedar streets.

Similar to the last. Sediment contained vorticella and microstoma. The volatile nitrogenous matter injected under my own skin produced diarrhœa and vomiting from which I took a week to recover.

To determine whether the above results were exclusively due to the volatile nitrogenous matters and whether they existed in the water as such, or were formed during distillation, further experiments were tried from time to time during the research. That these volatile nitrogenous matters preëxisted in the waters was, I thought, very probable. To ascertain this the waters were, after being filtered through asbestos plugs (in all other respects they were as when drawn from the wells), injected in considerable quantity under the skins of rabbits. Symptoms were produced very similar to those induced by the concentrated waters, and the distillates from the concentrated waters which had been found not to contain or develop the volatile nitrogenous matters. Well No. 86 greatly polluted, otherwise produced not the slightest discernable effect upon the animal's health, and when the free ammonia was allowed to accumulate in another portion and concentrated till it became two parts per million, on injection it produced exactly similar results.

In order to determine the effect of the less volatile portion of a water, some of that which had been filtered through the asbestos plugs of our other experiment, was distilled at a very low pressure at a temperature of about 84° C., as previous experiments had shown that all the readily volatile matters of this water were easily separated from it by heat, applied if for even a short time. That which remained and was injected in the rabbit produced little or no discernable effect. While in this and the first injectings, bacterial matter might have been implicated, the latter experiment would have failed on account of their sterilization by the heat applied. Yet the volatile matters, in which in every instance I am sure there were no bacteria present, produced more or less violent diarrhœa, with the exception, I might again mention, of that from well No. 77, which, although when concentrated, contained 7 parts per million, an amount equal to that in many of the others, produced no diarrhœa in the rabbit into which it had been injected. The only manner by which I can account for this is by assuming that the

term "volatile nitrogenous matters" is a very elastic one, and includes both virulent and harmless amine compounds. Of the former, those of phenol, toluol, etc., and of the latter, ethyl, etc. This is a part of the subject, however, that I trust to be enabled to further elucidate, while it suffices in the present communication to show that the volatile nitrogenous matters accompanying the other pollutants in a sewage contaminated water probably are injurious to health, and that in an examination of a water to determine its potability, their presence and amount should not be lost sight of.

N. Y. Laboratory, 133 Water St.

ABSTRACTS.

Abstracts from the *Journal of the London Chemical Society:* *E. Waller, Ph.D.*

On the Estimation of Hydrogen Sulphide and Carbonic Anhydride in Coal Gas. By Lewis T. Wright. (Vol. xliii. p. 267.)

Experiments with an absorption apparatus of the Frankland-Ward type showed that a manganese peroxide bullet introduced some gases with it mechanically, unless previously submitted to the action of a stream of coal gas for some hours, after which it removed a small amount of gas mechanically. Copper sulphate dried at 150° absorbed some gas mechanically. Copper phosphate moistened with syrupy phosphoric acid gave tolerably good results.

In experiments with absorption tubes, the amount absorbed being weighed, cupric sulphate was found to be objectionable for the following reasons: The sulphuric acid set free reacts with the hydrocarbons in the gas,—sulphurous acid will always form (whether the sulphate has been dried as recommended by Fresenius for four hours at 150°-160° or not.) The reagent also is not very sensitive to small amounts of H_2S. Ferric and manganic oxides are not sufficiently sensitive. Mercuric oxide steadily loses weight in a current of pure coal gas. Cupric phosphate was the most satisfactory. It was prepared by dissolving 2 lbs. Na_2HPO_4 (crystals?) in 1 gal-

lon of water and 2½ lbs. $CuSO_4$ 7 H_2O in 1½ gallons of water and mixing the solutions with vigorous stirring.

The precipitate was washed by decantation and then dried at 100°. Before using, this reagent requires to be completely "saturated" with pure coal gas, by slowly passing through the U tube containing it about 3 feet of gas free from H_2S.

The U tubes used were glass stoppered, and connected by tubes carrying stop cocks. The train used consisted of the meter next a 12 inch U tube containing pumice soaked in syrupy phosphoric acid—to remove ammonia next a tube filled with (neutral) calcium chloride, then a 6 inch tube, one leg of which was filled with the cupric phosphate, the other with neutral calcium chloride, and next a 6 inch U tube having one leg filled with moist soda lime, the other with calcium chloride. The results were slightly higher than when the same gas was caused to yield the H_2S & CO_2 together to soda lime.

Contributions to the Chemistry of the Cerite Metals. B. Brauner. (Vol. XLIII. p. 278).

Didymium oxide carefully purified, was converted into sulphate. The mean of five separate determinations gave an atomic weight of 145.42 for Di.

Another lot of didymium oxide when precipitated fractionally gave atomic weights ranging from 144.3 to 149.4, the last fractions giving the higher figures, indicating that previous determinations of the atomic weight 147.2 (Cleve) and 146.58 (Brauner) were probably high in consequence of the presence of at least one other element called provisionally (Di. gamma).

An examination of the absorption bands of a solution of the oxide having the highest atomic weight indicated the probability of the identity of this with samariun which probably has an atomic weight of 150.

Oxides of the yttrium metals, yttria, holmia, thulia, erbia and probably terbia, were found to exist in cerite.

Some Compounds of Antimony and Bismuth Containing two Halogens. R. W. Atkinson. (Vol. XLIII. p. 289).

The preparation of

$Sb_2Cl_3K_6Br_6 + 3\ H_2O$,
$Sb_2Cl_6K_2Br_2 + 2\ H_2O$,
$Sb\ Cl_2K\ Br + H_2O$,
and $Bi\ Cl_2K_2Br_2 + 1\frac{1}{2}H_2O$,

are described, and analytical results given.

The first mentioned salt when heated to between 200 and 300°, loses antimonious fumes, the antimony carrying with it half the bromine and half the chlorine, which precludes the theory that the constitution of the salt is 2 Sb. Cl_3 6 K Br. 3 H_2O.

Crystallographic Examination of the Crystals of Antimonio Potassic Chloro Bromide. R. H. Solly. (Vol. XLIII. p. 293.) Examination of the crystals of the salt first described in the preceding paper.

On the Gases Evolved During the Conversion of Grass into Hay. P. F. Frankland and F. Jordan. (Vol. XLIII. p. 294.)

The conclusions reached are :

1. That comparatively dry grass soon evolves considerable quantities of gas consisting almost wholly of carbonic anhydride, and accompanied by mere traces of hydrogen and hydrocarbous.

2. That the evolution of gas takes place with almost equal rapidity in atmospheres composed of air, carbonic anhydride, oxygen or hydrogen ; and that excepting when the atmosphere contains oxygen, in which case a notable proportion of nitrogen accompanies the carbonic anhydride, the composition of the gas evolved is much the same.

3. That when the decomposition of grass takes place under water, large volumes of gas are evolved which are characterized by the presence of a notable proportion of hydrogen. This hydrogen is doubtless due to the lactic fermentation induced by bacteria ; acetic, lactic, and probably propionic acids, together with bacteria, being found in the water in which the grass was immersed.

Note on an Aparatus for Fractional Distillation under Reduced Pressures. L. T. Thorne. (Vol. XLIII. p. 301.) Requires the accompanying illustration to be intelligible.

Notes on the Condition in which Carbon exists in Steel. Sir F. Abel and W. H. Deering. (Vol. XLIII. p. 303.)

First series of experiments. From one lot of steel (cold rolled) discs were taken, as received, after annealing, and after hardening. The process pursued in hardening and annealing are described. Treatment with a cold saturated solution of potassic dichromate to which $\frac{1}{20}$ of its volume of pure conc. $H_2S\,O_4$ had been added, left undissolved, dark particles appearing sparingly under the microscope, attracted by the magnet, containing in the case of the cold rolled, and annealed discs, iron and carbon in about the proportion of

Fe_6C_5, nearly all the carbon remaining in the residue. With the hardened disc only about one-sixth of the carbon remained in the residue, and the proportion of iron to carbon was much less with the others. The use of a larger proportion of H_2SO_4 in the bichromate solution seemed to break down the carbide, and dissolve the greater part of the iron.

Second series. Steel which had been melted from cemented blister steel and subsequently cold rolled and cross cold rolled, with annealing between the various rollings, was tested in a similar manner. The solutions used were :

Preparation 1. 0.8, the strength of Preparation 2.

2. Cold saturated solution of $K_2Cr_2O_7$ (99 grms. per litre) containing 0.9 grms. pure conc H_2SO_4 to each grm. of bichromate.

3. 0.44, the strength of Preparation 2.

4. 1.44 in one case and 1.65 in another, the strength of Preparation 2.

With the first three preparations 13.25 to 15.34 per cent. of carbide remained undissolved as a black powder attracted by the magnet, containing iron and carbon in the proportion for Fe_3C. Preparation 4. was evidently too concentrated for the carbide to resist decomposition by it.

The results (which are regarded only as preliminary) tend to confirm the view that carbon in steel exists as an iron carbide distributed through the mass.

On the Spectrum of Beryllium with Observations Relative to the Position of that Metal Among the Elements. W. N. Hartley. (Vol. XLIII. p. 316.) A map of the spectrum is given. The conclusion is that "the spectrum of beryllium exhibits no marked analogy with the calcium, the magnesium or the aluminium spectra, all of which are members of well defined homologous series. There is nothing similar to the boron, the silicon or carbon spectra, nor to those of scandium, yttrium or cerium. The spectrum of lithium is the one most allied to that of beryllium in the number, relative position and intensity of lines. * * * I am therefore led to the conclusion that beryllium is the first member of a dyad series of elements, of which in all probability calcium, strontium and barium are homologues."

On a New Oxide of Tellurium. E. Divers and M. Shimosé. (Vol. XLIII. p. 319.) By heating the compound of sulphur trioxide and tellurium in vacuo, until decomposition ensues, SO_2 and a

new oxide of tellurium were obtained. As thus prepared it resembles charred cork, but must be purified, by washing with dilute sodium carbonate, from sulphur oxides and tellurous acid. The oxide seems to be obtained in small quantities by the action of water on the sulphoxide, and also by pouring gradually the well-known purple red solution of tellurium in sulphuric acid into a large volume of water.

Its composition may be expressed by the name and formula *Tellurium monoxide* Te O, but its constitution is probably more complex than is thereby indicated. To prove the individuality of the compound, the action of reagents on, and the general properties of a mixture of pure tellurium with tellurium dioxide, were contrasted with those of the new oxide. The physical characters and action with reagents were altogether dissimilar.

On Tellurium Sulphoxide. E. Divers and M. Shimosé. (Vol. XLIII p. 323.)

The compound was discovered independently of R. Weber (Jour. Pr. Chem. XXIV. 218), the printed copy of his results having reached the author before their own research was completed. The properties of the substance were found to be as described by Weber with the exception that it was not found to be unstable as stated by him. The analyses indicated SO_2Te ; the formula also assigned by Weber, but the most of the results gave an excess of SO_2 probably present as an impurity. By prolonged heating in vacuo at 35° or almost instantaneously by heating to 90° the color changes from red to a bright fawn brown. This form has been called by the authors *beta* tellurium sulphoxide, as no change of composition occurs. Heated still further, to 130° the compound softens and shrinks, at 180° it begins to decompose SO_2 being evolved, the TeO described in the previous paper remaining. The decomposition is nearly complete at 230°.

On a New Reaction of the Tellurium Compounds. E. Divers and M. Shimosé. (Vol. XLIII. p. 329.) Sulphuric acid can hold in solution but small amounts of TeO_2 or its sulphate. But if this is poured upon zinc and the escaping hydrogen, containing hydrogen telluride, is passed into a solution containing tellurated sulphuric acid red tellurium sulphoxide makes its appearance in the liquid. By prolonged action of the current of gas, a brown compound, probably hydrogen pertelluride, precipitates, with forma-

tion of SO_2 which can be detected by passing the gas through potassium permanganate.

Abstracts from the Comptes Rendus, by A. Bourgougnon.

Action of Anhydrous Aluminium Chloride upon Acetone. By E. Louïse. (No. 14, Oct. 2, 1882.)

Amongst the most volatile products found during the reaction, there is mesityl oxide, boiling point, 128°—130° C; composition $C_6H_{10}O$; vapor density, 3.51. The less volatile product contains Phoron, boiling point, 195°—196° C, composition $C_9H_{14}O$.

Upon some Combinations of Disulphide and Diselenuride of Tin. By A. Ditte. (No. 15, Oct, 9, 1882.)

By the action of soluble sulphides upon the sulphides or selenurides of tin, crystallized salts analogous to stannates are obtained, in which selenium and sulphur take the place of oxygen.

Fermentation of Nitrates. By M. Gayon & Dupetit. (No. 15, Oct. 9, 1882.)

Upon the Reduction of Nitrates in the Soils. By P. P. Dehèrain and Maquenne (No. 16, Oct. 16, 1882.)

Under certain circumstances nitrates are reduced in the soils with production of nitrous oxide gas. The reduction of nitrates occurs only in soils containing a large amount of organic matter. The nitrates are not reduced when the atmosphere of the soils contains oxygen.

On Alunite. By P. Guyot. (No. 16, Oct. 16, 1882.)

The composition of alunite, from the mines of "La Tolfa," is not constant; the amount of alumina and potassium sulphate being variable. Crystallized alunite sometimes contains 30 per cent. of base, whilst sometimes the quantity of silica is so large that the proportion of base is reduced to 17.5 per cent. The average composition of alunite generally corresponds to—

Alumina	27.60
Sulph. acid	29.74
Potassium Oxide	7.55
Water	11.20
Iron	1.20
Silica	22.71
	100.00

Chronic Poisoning by Antimony. By C. de Poncy and C. Livon. (No. 16, Oct. 16, 1882.)

Separation of Gallium. By L. de Boisbacdran. (No. 17, Oct. 23, 1882.)

Methods for the separation of gallium from tin and antimony.

Determination of the Atomic Weight of Thorinum. By L. F. Nilson. (No. 17, Oct. 23, 1882.)

The determinations have been made with the sulphate Th (SO_4) + 9 H_2O. The average of six determinations gives the number 232.43. In another series of experiments four determination have given the number 232·3.

Upon the Reduction of Nitrates in Soils. By P. P. Dehérain and L. M. Maquenne. (No. 17, Oct. 23, 1882.)

Nitrates are not reduced in soils which have been heated. In the experiments the earth was placed in closed tubes and submitted to a temperature of 110°–120° C. When the soils contain vapors of chloroform, the nitrates are not reduced.

The nitrates are reduced when some fresh earth is mixed with earth which had been previously heated.

Separation of Gallium. By L. de Boisbaudran. (No. 17, Oct. 23, 1882.)

Separation of gallium from tin and antimony.

Chemical Studies on the Sugar-Beet. By H. Leplay. (No. 18, Oct. 30, 1882.)

A Rapid Method for the Determination of Salicylic Acid. By A. Rémont. (No. 18, Oct. 30, 1882.)

A modification of the process which consists in extracting salicylic acid with ether, and comparing the coloration given with perchoride of iron with the color obtained with standardized solutions of acid and the salt of iron.

Upon a Hydrate of Molybdic Acid. By F. Parmentier. (No. 19, Nov. 9, 1882.)

The yellow crystals deposited on the sides of the bottles containing solutions of ammonium molybdate in nitric acid are formed by a hydrate of molybdic acid Mo O_3 2 H_2O very sparingly soluble in water and acids.

Upon Monochlorinated Allylic Alcohol (Alpha) CH_2= CCl-CH_2 (OH) and its Derivatives. By L. Henry. (No. 19, Nov. 6, 1882.)

Monocholorinated allylic alcohol (alpha) CH_2–CCl–CH_2 (OH) is obtained by the action of a diluted solution of potassium oxide upon epibichlorhydrin CH_2–CCl-CH_2 Cl. It is a colorless liquid, sp : gr : at 19°C 1.164 ; boiling point, 136°C. Soluble in water.

Derivatives.—Acetic ether CH_2-CCl-CH-CH_2 ($C_2H_3O_2$) produced by the action of acetyl chloride, boiling point 145°C.

Bromhydric ether CH_2=CCl CH_2 Br., produced with phosphor-tri-bromide, Ph Br_3 boiling point 120° C.

Sulphocyanate produced by the action of the chloride (alpha) CH_2=CCl CH_2 I upon potassium sulphocyanate, boiling point 180°-181° C. Combined with ammonia it produces monochlorinates thiocinnamin, melting point 90°-91° C.

Chemical Studies of Sugar Beet. by H. Leplay. (No. 19, Nov. 6, 1882)

Upon the Reduction of Nitrates in the Soils, by P. P. Dehérain and M. Maquenne (No. 19, Nov. 6, 1882.) The authors have succeeded in determining the nature of the ferment reducing the nitrates in the soils. Some earth has been mixed with a solution of sugar (1 per cent.) and some potassium nitrates.

The gases evolved were composed of

Carbonic acid	80. 5.
Nitrous oxide	8. 2.
Nitrogen	11. 3.

The water collected with the gases had a strong odor of butyric acid and contained a large quantity of "bacillus amylobacter" these vibrios having most probably produced the fermention in the earth.

Chemical Studies on Sugar Beet, by H. Leplay. (No. 20, Nov. 13, 1882.)

Decomposition of Phosphate at a High Temperature, by H. Grandeau. (No. 20, Nov. 13, 1882.)

An inquiry into the conditions by which aluminium phosphate is decomposed at a high temperature by potassium sulphate.

Upon Œnocyanine, by E. J. Maumené. (No. 20, Nov. 13, 1882.

Œnocyanine is the coloring matter of black grapes and red wines, it is colorless in grapes before their maturation, it turns of a dark blue by exposure to air.

Decomposition of Hydrogen Dioxide by Fibrin, by A. Béchamp. (No. 20 Nov. 13, 1882.)

Pure fibrin freshly extracted from blood decomposes hydrogen dioxide, during this reaction the fibrin is modified, and after forty-eight hours of contact, it has no longer the power of decomposing hydrogen dioxide, if even put into contact with a fresh solution, it also has sustained a loss of weight.

A drop of hydrocyanic acid stops at once the decomposition of hydrogen dioxide by fibrin, and this acid is oxidized.

Researches on Lead Iodide, by M. Berthelot. (No. 21, Nov. 20, 1882.) Thermochemistry.

Production of Crystallized Uranates, by A. Ditte. (No. 21, Nov. 20, 1882.)

Sodium Uranate is obtained by the fusion in a platinum crucible of sodium chloride and green oxide of uranium, insoluble in water, easily soluble in soluble acids.

Calcium Uranate is produced by the reaction of calcium chloride upon green oxide of uranium. Strontium and barium uranates are produced by the same method. Yellow needles insoluble in water, soluble in diluted acids.

Mannitic Anhydride, by A. Fauconnier. (No. 21, Nov. 20, 1882.)

Is obtained by dry distillation in a vacuum of mannite, it is a colorless liquid, boiling at 160-190° C, composition $C_6 H_{10} O_4$,, very soluble in alcohol and water, insoluble in ether. Heated with acetic anhydride it gives $C_6 H_8 O_4 (C_2 H_3 O)_2$ a viscous liquid, nearly colorless, boiling point 197-198° C.

Phosphorus oxychloride is without action upon $C_6 H_4 O_{10}$, but phosphorus perchloride transforms it into $C_6 H_8 O_2 Cl_2$ having the form of hexagonal tables, very soluble in ether, less soluble in alcohol and benzine, insoluble in water, boiling point 143° C.

Chemical Studies on Corn, at different Stages of its Vegetation, by H. Leplay. (No. 23, Dec. 4, 1882.)

Upon a Method to Transform Tricalcic Phosphate into Chlorinated Compounds of Phosphorous, by T. Ribau. No. 23, Dec. 4, 1882.)

When a current of chlorine and carbon monoxide is directed upon a mixture of carbon and tricalcic phosphate, the phosphate is transformed at a low temperatureinto phosphorus oxichloride P O. Cl_3 with production of calcium chloride and carbonic dioxide.

$$P_2 O_5 (CaO)_3 + 2CO + 4Cl = P_2 O_5 CaO + 2CO_2 + 2 Ca Cl_2.$$

This equation represents the final result of the reaction, but in reality it can be divided into two distinct phases. First, chlorine and carbon monoxide transform the tricalcic phosphate into metaphosphate and calcium chloride without production of free phosphoric acid.

$$P_2 O_5 (CaO)_3 + 2CO + 4Cl = P_2 O_5 CaO + 2CO_2 + 2CaCl_2.$$

Second, the gaseous mixture changes the metaphosphate into phosphorus oxichloride.

$$P_2 O_5 CaO + 4CO + 8Cl = POCl_3 + 4CO_2 + CaCl_2.$$

Phosphorous oxichloride distilled over red hot charcoal is transformed into phosphorus trichloride.

$$PO Cl_3 + C = PCl_3 + CO.$$

A New Hydrocarbon, by E. Louïse. (No. 23, Dec. 4, 1882.) Benzylmesitylen is obtained by the reaction of benzyl chloride upon mesitylen in contact with anhydrous aluminium chloride.

Volta Prize. A prize of fifty thousand francs is offered and will be presented by the "Académie des Sciences," in December 1887, to the most successful discoverer of means tending to apply cheaply electricity as a source of light, heat, chemical action, mechanical power, transmission of dispatches or medical treatment. This concourse is open to the savants of all nationalities, and will close June 30, 1887.

Abstracts from *Berichte der Deutschen Chemischen Gesellschaft*, by Percy Neymann, Ph.B.

On the Preparation of Diphenyl—keton-oxide.—W. H. Perkin (vol. XVI. 339). In endeavoring to obtain the anhydride of salicylic acid this acid was heated with acetic acid anhydride. The acid is dissolved while acetic acid and acetic acid anhydride distil over. A thick liquid remained in the retort. When subjected to distillation a quantity of an oily substance passed over which solidi-

fied crystalline in the neck of the retort. This after being washed with alcohol and recrystallized from this gave figures from the analysis corresponding to the formula $C_{13}H_8O_2$. The product is evidently the same as that obtained by Merz and Weith by oxidation of methylen-diphenyl-oxide and that obtained by Richter by distillation of salicylate of potassium with phosphorus oxychloride.

On Sulphocyanpropimin.—J.Tscherniac and C.H.Norton (vol. XVI.p.345). When monochlor-aceton and ammonium sulphocyanate act upon each other in alcoholic solution, the sulphocyanate of a new base is formed.

$$2\ NH_4SCN + C_3H_5O\ Cl = NH_4Cl + H_2O + C_4H_6N_3S.HSCN.$$

Investigation has shown that this reaction takes place in two phases ; at first sulpho-cyan-aceton is formed :

$$NH_4SCN + C_3H_5ClO = NH_4Cl + C_3H_5—OSCN,$$

but this latter is caused to decompose by the presence of sulphocyanate of ammonia, a sulphocyanate $C_4H_6N_2S.HSCN$ being formed while water is separated :

$$CH_2SCN.CO.CH_3 + NH_4SCN = (CH_2SCN.CNH.CH_3)HSCN + H_2O.$$

The authors propose the term sulphocyanpropimin for this new base $C_4H_6N_2S$.

On Sulphocyanaceton.—J.Tscherniac and R.Hellon(vol.XVI.p. 348). 175 grms. of sulphocyanate of barium are dissolved in 525 grms. of alcohol and 100 grms. of monochloraceton are added. The mixture is left to itself several days and when no more precipitate forms this is filtered and washed with alcohol. The alcoholic solution evaporated on a water-bathe leaves crude sulphocyanaceton as a syrupy mass ; this is boiled with ten times its bulk of water and the water solution is left to itself for 24 hours. The clear supernatant liquid is decanted and evaporated on a water bath. An oily mass separates. Washing and drying over sulphuric acid finally gives the pure sulphocyanaceton. Its formula is $CH_2SCN.CO.CH_3$. It is an oil, only slightly colored when first made, but acquires a deep red color when exposed to the air.

On a New Industrial Method of Preparing Paper Pulp. —(Vol. XVI., p. 350.) G. Archibald. Wood or straw is cut in pieces, macerated with milk of lime transferred, to a digestor after

12 hours and saturated with sulphurous acid, at the same time applying a pressure of five atmospheres for one to two hours. The material is then washed with water and again treated under pressure with three per cent. calcium chloride and half per cent. aluminium sulphate. After these substances have been washed out, the pulp resembles cotton in appearance, and can be employed for manufacturing finer grades of paper at once. The process requires about three hours after the treatment with milk of lime. The process is patented in the United States and Canada.

On the Occurrence of Methyl Alcohol in the Products Obtained from Colophonium by Dry Distillation.—(Vol. XVI., p. 351.) Werner Kelbe and J. Livoff. Among the products obtained by dry distillation of colophonium is a small quantity of a liquid containing considerable quantities of acetic acid and in very small quantities higher homologues of this acid. Based upon the fact that methyl alcohol is produced by the dry distillation of numerous organic substances this liquid was examined for and found to contain methyl-alcohol, but not in sufficient quantity for practical purposes.

On the Conversion of Nitrils into Imides. The Behavior of Hydrocyanic Acid and of Ethelencyanide to Hydrochloric Acid and Alcohol.—A. Pinner. (Vol. XVI., p. 352.) As previously described, when hydrochloric acid is introduced into a mixture of equal parts of a nitril and an alcohol an amido-chlor-ether is first formed:

$$R.CN + R^1OH + 2HCl \quad R.C\begin{matrix}\diagup NH_2\\ —OR^1.HCl\\ \diagdown Cl\end{matrix}$$

this is, however, very unstable, soon loses a molecule of hydrochloric acid and is converted into the hydrochlorate of an imido-ether:

$$R.C\begin{matrix}\diagup NH_2\\ —OR^1—HCl\\ \diagdown Cl\end{matrix} \quad RC\begin{matrix}\diagup\!\!\diagup NH\\ \\ \diagdown OR^1\end{matrix} \quad HCl + HCl$$

At the time these investigations were made, the nitril of formic acid, hydro-cyanic acid, was also experimented upon, but the reaction ensued in a totally unexpected manner. By introduction of hydrochloric acid gas into an absolute alcoholic solution of hydrocyanic acid, free from water, energetic detonations took place, and by par-

tial throwing out of the mass chloride of ammonium was produced in large quantities and not any form-imido-ether :

$$(CHN + C_2H_5OH + HCl \quad CH\begin{matrix}\diagup\!\!\diagup NH \\ \diagdown OC_2H_5\end{matrix} .HCl)$$

but only chlorethyl, formic ether and the ethyl ether and amid of diethylglyoxylic acid were formed :

$$\underset{\text{ether.}}{CH(OC_2H_5)_2.COOC_2H_5} \text{ and } \underset{\text{amid.}}{CH(OC_2H_5)_2.CONH_2}$$

Recently the author has found the conditions and circumstances necessary to obtain the form-imido-ether and also the causes to which was due the prevention of formation of this ether in the previous experiments. The form amido ether

$$C\begin{matrix}\diagup NH \\ \diagdown OC_2H_5\end{matrix}$$

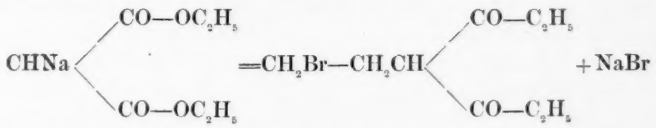
is decomposed in very short time by alcohols ; hence in order to produce the form imido-ether it is necessary to avoid every excess of alcohol and to prevent any warming of the mass. The mass consisting of absolutely hydrocyanic acid and four times its weight of ether, free from water and alcohol, must be shaken continually while the dry gas is introduced. The gas is absorbed—when free acid appears the operation is stopped. The liquid will have taken up nearly two molecules of acid. The formo-chlor-amido-ether has been formed as chlorohydrate :

$$CH\begin{matrix}\diagup NH_2 \\ —OC_2H_5.HCl \\ \diagdown Cl\end{matrix} \quad CHN + C_2H_6O + 2HCl$$

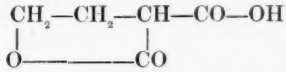
To prevent an accident the mass must remain in the surrounding cooling mixture for half an hour longer with continued shaking. During this time beautiful crystals will begin to be deposited, finally converting the entire contents into a crystalline mass. The author describes numerous derivatives and also the succinimido-ether and its derivatives.

On a New Unsaturated Acid Isomeric with Itaconic Acid. Rud. Fittig and Fr. Roeder. (Vol. XVI., p. 372). In order to obtain a general method for preparing lactonic acids and lactones of a given constitution ethlyen bromide (1 Mol.) was al-

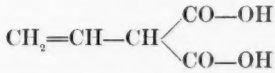
lowed to act upon sodium-malonic-acid-ether (1 Mol.). The reaction was supposed to take place :



thus forming a bromidized ethyl-malonic-acid-ether and by saponification of this the carbon acid of butyro-lactane :



The crystalline acid obtained had the formula $C_5H_6O_4$ but from its salts it was found to be the isomeric unsaturated acid of the above lactonic acid.

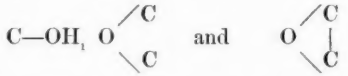


Microscopic Examination of Printed Cotton Goods. (Vol. XVI,. p. 455). RICHARD MEYER. The author makes use of the microscope to ascertain whether the dye as such has been produced inside of the fibre or whether it has been employed already formed and fixed by means of albumen. Both methods can be employed for the same dye. For example, a method much employed is to impregnate the fibre with a soluble lead salt, to precipitate this as hydroxide, carbonate or sulphate and then to convert it into the fiery reddish-yellow, basic chromate of lead. In combination with steam dyes it may, however, be much more convenient to print the chrome-orange already precipitated with albumen and fix it by steaming. The method of detecting the difference the author gives thus : If the fabric is macerated using a needle so that the single fibres can be isolated, these will appear equally colored throughout their entire mass if they have been colored by a dissolved dye. The characteristic form of the fibre remains unaltered, and it can be plainly seen that the coloring matter is deposited equally in the interior of the fibre. When the albumen method has been used the fibre appears entirely without color. At various points dyed bits of coagulated albumen will appear gummed to the fabric, and some of these particles will be found isolated in consequence of the maceration.

New Methods of Forming Pyro-Sulphuryl-Chloride and Chloro-Sulphonic Acid. G. Billitz and K. Heumann. (Vol. XVI., p. 483). 140 grms. of chlorosulpho acid and 130 grms. of pentoxide of phosphorus were heated with the reversed condenser. After the evolution of hydrochloric and sulphurous acid ceased the mass was distilled at 135–150°. This sinks in water while chlorosulpho acid unites with water, accompanied by a hissing noise. 93 per cent. of the theoretical amount of pyrosulphuryl chloride were obtained. The formation of pyrosulphuryl chloride from chloro-sulpho acid by means of pentoxide of phosphorus agrees with the formation of pyrosulphuric acid from sulphuric acid by means of a dehydrating agent :

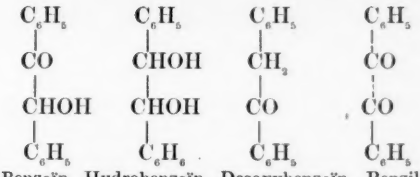
Contributions to the Knowledge of Hydroxylamin Reactions. E. Naegeli. (Vol. XVI., p. 494.) The author, by a series of experiments, finds it a valuable truth that hydroxylamin can be employed in general and easily whether in compounds which contain carbon, hydrogen and an atom of oxygen the group C=O or another group, such as

etc., is present. In order to determine by the *non-occurrence* of a reaction when hydroxylamin is employed that it contains no aldehyde-or ketone group, and on the other hand to accept the formation of an isonitroso compound as a proof of the presence of aceton or aldehydcarbonyl, it was necessary to try compounds of known constitution. This was done by the author and the law was found to be correct. All ketones so tested gave acetoximes ; but the compounds with the groups :



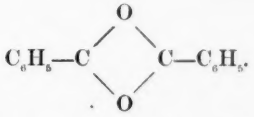
behaved indifferently to hydroxylamin such as alcohol, ether, ethylenoxyd.

On Benzil. Max Wittenberg and Victor Meyer. Vol. XVI., p. 500.) The constitution of benzoïn and its nearest relatives are usually expressed as follows :

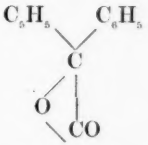


Benzoïn. Hydrobenzoïn, Desoxybenzoïn. Benzil.

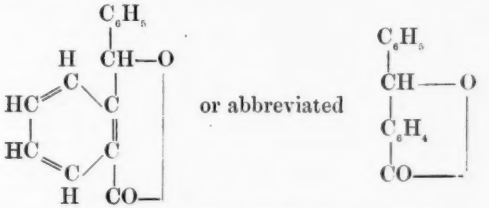
of these, however, only that of Desoxybenzoïn can be assumed to be correct with certainty. The authors state that the formula in common use for benzil is incorrect, C_6H_5–CO–CO–C_6H_5, as also the older formula :



Based on a number of experiments, the authors conclude about as follows : "By the investigations we think it proven that benzil contains but one carbonyl group. If we hence assume the formulæ just given for benzil to be incorrect we are still not capable of replacing either of them by a formula which we could rely upon. We would mention, however, that the formula formerly in use,



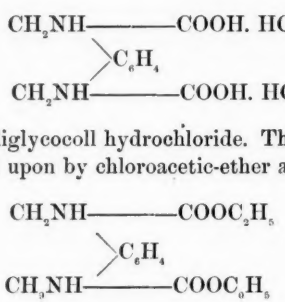
coincides with what we have found in reference to the position of the oxygen, and we will also not admit that our investigations could also be of considerable value if benzïl was considered as a lactone, probably of the following formula :



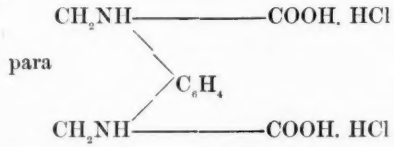
But against this formula also much can be said.

Action Chloro-acetic Ether on Primary diamines. J. Zimmermann and M. Knyrim. (Vol. XVI, p. 514.) By the action of chloroacetic-ether on meta-phenylen-diamine, meta-phenylen-diglycocoll-ether and phenylen-diamin hydrochloride are produced. If phenylendiglycocoll-ether is heated with strong hydrochloric acid with the reversed condenser or in sealed tubes at 100° crystals will separate on cooling. The analysis of these corresponds to the formula:

which is phenylen-diglycocoll hydrochloride. The para-phenylendiamin was also acted upon by chloroacetic-ether and the compound



was treated with hydrochloric acid in the same manner, giving



On M-nitrophenyl Mustard Oil. H. Standemann. (Vol. XVI., p. 548.) Meta-nitro-sulpho-carbanilid, $CS\begin{matrix}NHC_6H_5\\NHC_6H_4NO_2\end{matrix}$ was dissolved in hot acetic acid anhydride; water was added, and the mixture boiled for a short time. An oil separates, which deposits crystals upon cooling. The reaction which by simple decomposition would yield phenyl-mustard oil, nitro-phenyl mustard oil, nitro-acetanilid or acetic acid and nitro-anilin, and acetanilid or anilin acetate respectively, seems to be a more complicated one in consequence of secondary reactions. If glacial acetic acid is added to the solution containing the deposited oil, crystals are obtained, more rapidly by the addition of little water. By pressing they are separated from adhering phenyl-mustard oil and are obtained pure by distilling with steam. They melt at 58°, and at that tempera-

ture emit the odor characteristic of all mustard oils. The analysis corresponds to the formula $CSNC_4H_4NO_2$.

On Nitro-derivatives of Resorcin. P. G. W. Typke. (Vol. XVI., 551). Diacetyl-resorcin was taken as a starting point. It was prepared by allowing 80 grms. of acetyl-chloride and 50 grms. of resorcin to act upon each other under a reversed condenser. The boiling point is 275°C.

Dinitro-resorcin was prepared by stirring diacetyl-resorcin into four or five times its volume of fuming, strongly cooled nitric acid, and then pouring the mixture upon ice. The nitro-compound separates as a white amorphous powder. This, after washing, pressing, extracting with alcohol and drying at 100°C., was saponified by boiling with 30 per cent. hydrochloric acid under a reversed condenser. In order to separate this new compound from styphnic acid all was dissolved in a large quantity of hot water. On cooling the dinitro resorcin separated in fine needles. They melt at 212.5°C. They are best purified by crystallizing from boiling acetic ether. The analysis gives the formula $C_6H_2(NO_2)_2(OH)_2$. Mono-brom-di-nitro-resorcin, $C_6HBr(NO_2)_2(OH)_2$ is prepared from dinitro resorcin in glacial acetic acid solution and an excess of bromine.

Diamido-resorcin chloride $C_6H_2(OH)_2(NH_2)_2 2HCl$ is prepared by reducing dinitro-resorcin at water-bath temperature by means of tin and hydrochloric acid. Oxidation probably gives rise to a di-imido-resorcin $(HO)_2C_6H_2.(NH)_2$.

The constitution of di-nitro-resorcin could not yet be determined.

On the Action of Bromine in Alkaline Solutions on Amines. A. W. Hofmann. (Vol. XVI., p. 558.) If the hydrochloric acid solution of a primary monamine of the fatty series is treated with an alkaline solution of bromine, mono-alkylated brom-nitrogens are produced, which contain two atoms of bromine. The reaction was at first tried on the methyl and ethyl series and the compounds CH_3NBr_2 and $C_2H_5NBr_2$ were prepared and investigated ; the experiments were then extended to amines of the propyl and pentyl series, two amylmines, the sextylamin and octylamin all have given analogous derivatives.

If an alkaline bromine solution is permitted to act upon a secondary amine of the fatty series, the primary alkylamin is formed by the separation of alkylenbromide if the secondary amin contains

two alkyl groups. But if a secondary amine in which a double group of atoms has taken the place of two hydrogen atoms of the ammonia, is treated with bromine, an alkylenated brom-nitrogen is formed which contains only one atom of bromine. The formation of piperidin and coniïn derivatives has been studied.

$C_5H_{10}NBr$ and $C_8H_{16}NBr$.

The latter is especially interesting, and it was found by separation of hydrobromic acid, analogous bases are formed. This transformation may be perfected by acids or bases, and bases of the same composition, but of different properties, are produced.

If an acid is permitted to act upon the coniïn derivative $C_8H_{16}NBr$ a base of the formula $C_{18}H_{15}N$ is formed. It is very much like coniïn but boils at 150°C., which is 10° less than coniïn. It is a tertiary while coniïn is a secondary base.

Alkalies convert the brom-coniïn into a base of the same composition but it is a secondary base, $C_5H_{14}NH$, and boils at 173°C. By reduction of these bases coniïn, and finally octylamin and octane are formed. These new compounds complete the desired series of amines with eight carbon atoms. There are known :

Collidin	$C_8H_{11}N$
Tropidin	$C_8H_{13}N$
New Coniïn Derivatives	$C_8H_{15}N$
Coniïn	$C_8H_{17}N$
Octylamin	$C_8H_{19}N$

The reactions with piperidine are more complicated. They have not been fully studied.

An Easy Method of Preparing Paraffines. B. Koehnlein. (Vol. XVI., p. 560.) In comparing the interchanges taking place between organic and inorganic halogen compounds an easy method was found by which the homologues of marsh gas, the hydrocarbons C_nH_{2n+2} could be prepared.

2.5 grms. of pure chloride of aluminium free from chlorine and water, and 9.6 grms. of pure dry N-propyl-iodide in the proportion $AlCl_3 + 3C_3H_7I$ were mixed in a tube. The air was exhausted, the tube drawn to a fine capillary point and heated several hours to 130°–140°C. On cooling three substances could be distinguished On opening the tube a gas was ejected with great force. In a

second experiment this gas was caught and proved to be pure propane.

2.40 grms. $AlCl_3$ and 0.88 grms. of C_4H_9I heated in sealed tube to 120°C gave pure butane.

2.58 grms. $AlCl_3$ and 9 grms. C_2H_5I heated five hours to 140°–150°C. gave pure ethane.

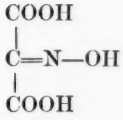
More investigations are in progress.

Some Observations on Piperidin and Pyridin. A. W. Hofmann. (Vol. XVI., p. 586.) The remarkable transformation of coniïn by the action of bromine (see above) gave cause to investigate the action of bromine on piperidin, and several experiments were successful, it being possible to prepare pyridin directly.

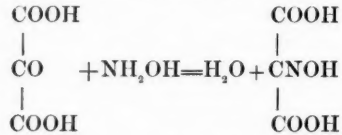
The aceto compound was used for a starting point. If a mixture of 1 mol. of the aceto compound is heated with 2 mol. bromine very gently, the temperature rises without more application of heat, and a colorless liquid distils over, leaving a syrupy residue. The distillate boils between 80° and 200°C., and is a mixture of acetylbromide and its bromine substitution products.

If from the residue the bases are liberated by alkali and driven off with steam, an aqueous distillate smelling strongly of pyridin is found floating a basic oil layer carrying crystals. These when pressed and purified from alcohol have the melting point 112°C. They were found to be bibrom-pyridin. If pyridin was formed it was to be looked for in the aqueous distillate. Caustic potash separated an oil having the pungent odor of pyridin. The dried distillate boiled at 110°–120°, and was a mixture of pyridin and piperidin. They were separated by fixing the piperidin as an aceto compound. The base now distilled between 112° and 116°C, and no longer became heated with acetic anhydride. It was almost pure pyridin.

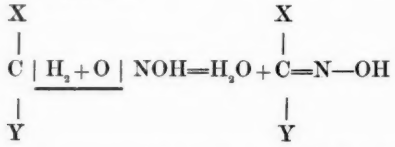
On the Constitution of Nitroso-Malonic Acid. Victor Meyer and A. D. Mueller. (Vol. XVI. p. 608). It has been found by the authors that nitroso-malonic-acid is an iso-nitroso compound, having the formula :



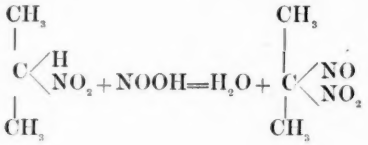
and that it could be formed from mesoxalic acid and hydroxylamin:



From this and other points the authors conclude that nitrogen compounds which are produced by the action of nitrous acid on the CH_2 group are always iso nitroso-compounds. They are produced according to the equation:



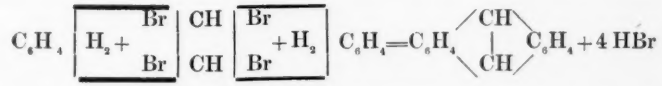
But if nitrogen compounds are formed by the action of nitrous acid on the group CH, when this is connected with a radical which can be easily removed, such as carboxyl, iso nitroso compounds are formed with the group C=N—OH; but if nitrous acid acts upon CH groups which have radicals which are not easily removed, actual nitroso-compounds are formed containing the group C—NO. All aromatic nitroso compounds and the pseudo nitroles of the fatty series, the first representative of which is formed according to the equation:



belong to this category.

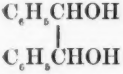
A New Synthesis of Anthracene. R. Anschuetz and F. Eltzbacher. (Vol. XVI. p. 623.) According to the experience with aluminium chloride synthesis, it seemed probable that by the action of aluminium chloride on the two isomeric tetra-brom-ethanes—in benzol solution the term isomeric tetra-phenyl-ethanes would be formed. Owing to an uncertainty whether the tetraphenyl-ethane experimented upon was one and the same at all times, or whether there were two different ones, the authors undertook to

study the action of aluminium chloride upon a benzol solution of acetylentetrabromide. From the product of the reaction a substance is easily isolated which proved to be anthracene in place of the expected tetra-phenyl-ethane. The reaction could probably be assumed as follows :

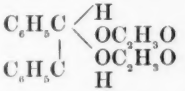


The investigations are to be continued.

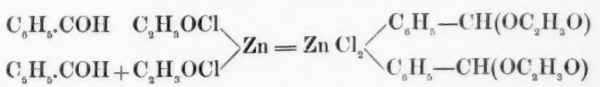
On the Action of Acetyl-Chloride on Benzaldehyde in Presence of Zinc Dust. C. PAAL. (Vol. XVI. p. 636.) The compound formed was formerly given the formula $C_9H_8O_2$. When reduced with hydriodic acid and amorphous phosphorous it is converted into dibenzyl $C_{14}H_{14}$ and distilled over zinc dust it forms stilben $C_{14}H_{12}$. Sodium amalgam was made to act upon an alcoholic solution of the substance at 70°–80°. The purified product melts at 138°C. and by analysis is found to be identical with hydrobenzoïn



The compound $C_9H_8C_2$ reduced is decomposed, forming hydrobenzoïn and acetic acid. This makes the assumed formula very improbable, and pointed more to the hydrobenzoïn-diacetate.



The formation of this compound by this method can probably be explained by the equation—

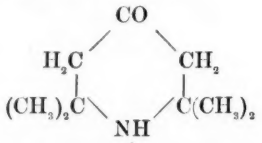


Some benzoic acid is also formed, showing that same oxidation also takes place.

On the Oxidation of Piperidin. C. SCHOTTEN. (Vol. XVI. p. 643.) Piperidin when treated as its urethane with fuming nitric acid produces a saturated amido acid $C_4H_9O_2N$, which differs from

the coniïn acid by C_3H_6 in the same manner as piperidin differs from coniïn by minus the group C_3H_6. Intermediate products of oxidation are formed, which are also described.

Note on Triacetonalkylamin. EMIL FISCHER. (Vol. XVI. p. 649.) Heintz gives it the formula—



If this is correct the alkylamin produced by reduction must be an hydroxylated tetramethylpiperidin. In order to prove this it was tried by abstracting water from triacetonal kylamin to convert it into a base of the piperidin series containing no oxygen. The reaction with a mixture of penta-chloride of phosphorous and oxychloide of phosphorous is very complicated. The reaction with conc. sulphuric acid is more simple. The free base forms a well crystallized hydrate with water. The analysis of the hydrochloriate gave figures corresponding approximately to the formula $C_9H_{17}N.HCL$.

NO. OF PUMP AND LOCATION.		A						100 CC DISTILLED. B						C 10 cc of P. M. & P. add			
		Residue at 100° C.	Loss of Residue at Low Red Heat.	Chlorine.	Nitrites.	Nitrates.	Oxygen by Moist Combustion.	1st 10 cc. NH_3	2d 10 cc. NH_3	3d 10 cc. NH_3	4th 10 cc. NH_3	5th 10 cc. NH_3	Total Free NH_3	1st 10 cc. NH_3	2d 10 cc. NH_3	3d 10 cc. NH_3	4th 10 NH_3
No. 76, cor. Johnson and Lawrence sts., Brooklyn.	Same day,	391.000	71.000	56.000	.190	4.820	8.140	.010	.005	Nil	.....	.....	.150	.048	.005	.002	Nil
	After 48 hours,	.....	.....	.....	.210	5.030	7.190	.015	.010	.002	.....	.....	.270	.032	.007	.001	.0003
	" 6 days,	.....	.....	.....	.260	4.620	6.930	.020	.003	Nil	.....	.....	.230	.030	.008	.001	Nil
No. 76, cor. Myrtle ave. and Lawrence st., Brooklyn.	Same day,	612.000	272.000	182.000	.720	7.060	3.260	.007	.002	Nil	.....	.....	.090	.022	.001	Nil	Nil
	After 48 hours,	.....	.....	.....	.860	7.410	2.840	.012	.004	.0005	.....	.....	.165	.018	.002	.0005	Nil
	" 6 days,	.....	.....	.....	.930	7.210	2.780	.009	.004	.0010	.....	.....	.140	.014	.003	.0010	.001
No. 77, cor. Bridge and Tillary sts., Brooklyn.	Same day,	996.000	368.000	130.000	.090	4.130	6.190	.004	.007	Nil	.....	.....	.050	.014	.002	.001	Nil
	After 48 hours,	.....	.....	.....	.100	4.210	6.030	.005	.007	Nil	.....	.....	.060	.013	.002	.001	Nil
	" 6 days,	.....	.....	.....	.110	4.200	5.900	.004	.007	.001	.....	.....	.060	.012	.002	.001	.001
No. 78, cor. Sumner ave. and Bainbridge st., Brooklyn.	Same day,	336.000	94.000	25.000	1.120	6.230	14.080	.090	.037	.013	.0025	Nil	1.425	.053	.025	.018	.014
	After 48 hours	.....	.....	.....	.940	7.460	13.960	.093	.042	.005	.0030	Nil	1.430	.062	.049	.011	.002
	" 6 days,	.....	.....	.....	.921	7.540	13.740	.106	.052	.005	.0030	.002	1.680	.068	.031	.023	.006
No. 79, cor. Bridge and Johnson sts., Brooklyn.	Same day,	805.000	432.000	74.000	1.040	7.210	8.420	.025	.010	.002	.....	.....	.370	.025	.003	.001	Nil
	After 48 hours,	.....	.....	.....	.940	7.420	7.980	.031	.008	.002	.....	.....	.410	.020	.005	.001	Nil
	" 6 days,	.....	.....	.....	.930	7.060	7.630	.036	.003	.001	.....	.....	.400	.023	.002	.001	Nil
No. 80, cor. Bridge st. and Chapel place, Brooklyn.	Same day,	862.000	419.000	94.000	.080	2.160	4.130	Nil	Nil	.....	.....	.....	Nil	.037	.004	.004	Nil
	After 48 hours,	.....	.....	.....	.110	2.060	4.010	Nil	Nil	.....	.....	.....	Nil	.034	.006	.002	.002
	" 6 days,	.....	.....	.....	.120	2.240	3.860	.001	Nil	.....	.....	.....	.010	.030	.009	.002	.001
No. 81, cor. Fulton ave. and Irving place, Brooklyn.	Same day,	600.000	260.000	130.000	.370	4.130	4.060	.006	.002	Nil	.....	.....	.080	.110	.035	.009	.003
	After 48 hours,	.....	.....	.....	.396	4.200	4.010	.006	.002	.001	.....	.....	.090	.102	.039	.010	.002
	" 6 days,	.....	.....	.....	.420	4.190	3.870	.007	.003	.001	.....	.....	.110	.014	.029	.005	.003
No. 82, cor. Bridge and Nassau sts., Brooklyn.	Same day,	745.000	179.000	140.000	.230	3.480	2.190	Nil	Nil	.....	.....	.....	Nil	.008	.002	.0010	Nil
	After 48 hours,	.....	.....	.....	.320	3.540	2.060	Nil	Nil	.....	.....	.....	Nil	.009	.002	.0010	Nil
	" 6 days,	.....	.....	.....	.240	3.630	1.980	Nil	Nil	.....	.....	.....	Nil	.008	.002	.0005	Nil
No. 83, cor. Fulton and Carleton aves., Brooklyn.	Same day,	576.000	326.000	102.000	.180	3.460	5.580	.002	.0010	Nil	.....	.....	.030	.013	.001	Nil	.....
	After 48 hours,	.....	.....	.....	.190	3.620	5.320	.002	.0010	.0005	.....	.....	.035	.012	.002	.0005	.....
	" 6 days,	.....	.....	.....	.210	3.840	5.180	.003	.0015	.0005	.....	.....	.050	.010	.002	.0005	.....
No. 84, cor. Duffield and Johnson streets, Brooklyn.	Same day,	673.000	227.000	42.000	.620	4.030	2.940	.0005	Nil	.....	.....	.....	.005	.005	.001	Nil	.....
	After 48 hours,	.....	.....	.....	.600	4.060	2.740	.0010	Nil	.....	.....	.....	.010	.004	.001	Nil	.....
	" 6 days,	.....	.....	.....	.630	3.920	2.360	.0010	.0005	.....	.....	.....	.015	.003	.002	.001	.....
No. 85, cor. Hanover pl. and Fulton ave., Brooklyn.	Same day,	649.000	350.000	90.000	.310	3.170	6.420	.0005	Nil	.....	.....	.....	.005	.009	.003	.001	Nil
	After 48 hours,	.....	.....	.....	.320	3.210	6.220	.0010	Nil	.....	.....	.....	.010	.008	.003	.001	Nil
	" 6 days,	.....	.....	.....	.300	3.460	5.940	.0015	.0005	.....	.....	.....	.020	.010	.002	Nil	Nil
No. 86, cor. Thames and Church streets, N. Y. City.	Same day,	774.000	562.000	6.000	.720	7.160	11.060	.005	.007	.0010	Nil	.....	.070	.055	.003	.001	Nil
	After 48 hours,	.....	.....	.....	.730	7.020	11.230	.006	.002	.0010	.0010	.....	.100	.048	.004	.002	.001
	" 6 days,	.....	.....	.....	.810	7.240	10.820	.009	.003	.0015	.0005	.....	.140	.038	.008	.002	Nil
No. 87, cor. Greenwich and Dye sts., N. Y. City.	Same day,	394.000	318.000	6.000	.420	3.460	7.420	.0015	.0002	Nil	.....	.....	.017	.028	.0065	.002	Nil
	After 48 hours,	.....	.....	.....	.450	3.210	7.510	.0020	.0005	Nil	.....	.....	.025	.024	.0070	.001	Nil
	" 6 days,	.....	.....	.....	.510	3.680	7.380	.0020	.0010	.0005	.....	.....	.035	.022	.0040	.001	.001
No. 88, cor. Cedar and Church sts., N. Y. City.	Same day,	326.000	214.000	4.000	.190	4.270	5.110	.002	.0005	Nil	.....	.....	.025	.027	.0065	.0005	Nil
	After 48 hours,	.....	.....	.....	.200	4.030	6.210	.002	.0010	Nil	.....	.....	.030	.021	.0080	.0020	.001
	" 6 days,	.....	.....	.....	.310	4.400	5.320	.003	.0010	.0005	.....	.....	.045	.023	.0040	.0010	.001

PARTS PER MILLION.

100 CC DISTILLED.																
				C 10 CC OF P. M. & P. ADDED AND WATER.							100 CC DISTILLED WITH P					
c.	3d 10 cc. NH_3	4th 10 cc. NH_3	5th 10 cc. NH_3	Total Free NH_3	1st 10 cc. NH_3	2d 10 cc. NH_3	3d 10 cc. NH_3	4th 10 cc. NH_3	5th 10 cc. NH_3	Total Albuminoid. NH_3	1st 10 cc. NH_3	2d 10 cc. NH_3	3d 10 cc. NH_3	4th 10 cc. NH_3	5th 10 cc NH_3	
	Nil	.....	.....	.150	.048	.005	.002	Nil	.....	.550	.048	.024	.006	.0010	Nil	
	.002	.....	.....	.270	.032	.007	.001	.0005	.....	.405	.046	.027	.003	.0005	Nil	
	Nil	.....	.....	.230	.030	.008	.001	Nil	.....	.390	.054	.018	.001	Nil	Nil	
	Nil	.....	.....	.090	.022	.001	Nil	Nil	.....	.230	.0305	.0130	.0035	Nil	Nil	
	.0005	.....	.....	.165	.018	.002	.0005	Nil	.....	.205	.0300	.0090	.0070	.0040	.0005	
	.0010	.....	.....	.140	.014	.003	.0010	.001	.....	.190	.0380	.0080	.0010	.0005	.0005	
	Nil	.....	.....	.050	.014	.002	.001	Nil	.....	.170	.021	.013	.003	Nil	.....	
	Nil	.....	.....	.060	.013	.002	.001	Nil	.....	.160	.023	.008	.004	.001	.....	
	.001	.....	.....	.060	.012	.002	.001	.001	.....	.160	.020	.013	.002	.001	.....	
	.013	.0025	Nil	1.425	.053	.025	.018	.014	.001	1.130	.205	.080	.022	.007	.002	
	.005	.0030	Nil	1.430	.062	.049	.011	.002	.002	1.260	.261	.064	.014	.002	.001	
	.005	.0030	.002	1.680	.068	.031	.023	.006	.001	1.290	.274	.072	.018	.008	.007	
	.002	.....	.....	.370	.025	.003	.001	Nil	.....	.290	.091	.019	.004	.001	.001	
	.002	.....	.....	.410	.020	.005	.001	Nil	.....	.260	.087	.016	.006	.002	.001	
	.001	.....	.....	.400	.023	.002	.001	Nil	.....	.260	.069	.026	.007	.004	.002	
	.....	.....	.....	Nil	.037	.004	.004	Nil	.....	.450	.036	.009	.002	.001	Nil	
	.....	.....	.....	Nil	.034	.006	.002	.002	.....	.430	.042	.006	.002	.001	Nil	
	.....	.....	.....	.010	.030	.009	.002	.001	.....	.420	.040	.008	.003	.001	Nil	
	Nil	.....	.....	.080	.110	.035	.009	.003	Nil	1.570	.121	.040	.011	.002	Nil	
	.001	.....	.....	.090	.102	.039	.010	.002	.001	1.540	.136	.032	.004	.002	Nil	
	.001	.....	.....	.110	.014	.029	.005	.003	.001	1.520	.122	.041	.007	.003	.0015	
	.....	.....	.....	Nil	.008	.002	.0010	Nil	.....	.110	.009	.002	.002	.001	Nil	
	.....	.....	.....	Nil	.009	.002	.0010	Nil	.....	.120	.010	.006	.002	Nil	Nil	
	.....	.....	.....	Nil	.008	.002	.0005	Nil	.....	.105	.009	.005	.003	.002	Nil	
	Nil	.....	.....	.030	.013	.001	Nil	.....	.....	.140	.0140	.001	.0005	Nil	.....	
	.0005	.....	.....	.035	.012	.002	.0005	.....	.....	.145	.0090	.003	.0020	Nil	.....	
	.0005	.....	.....	.050	.010	.002	.0005	.....	.....	.125	.0110	.004	.0010	Nil	.....	
	.....	.....	.....	.005	.005	.001	Nil	.....	.....	.060	.009	.006	.001	.0005	Nil	
	.....	.....	.....	.010	.004	.001	Nil	.....	.....	.050	.008	.006	.002	Nil	Nil	
	.....	.....	.....	.015	.003	.002	.001	.....	.....	.060	.009	.006	.001	.0015	Nil	
	.....	.....	.....	.005	.009	.003	.001	Nil	.....	.130	.011	.004	.002	.001	Nil	
	.....	.....	.....	.010	.008	.003	.001	Nil	.....	.120	.012	.005	.001	Nil	Nil	
	.....	.....	.....	.020	.010	.002	Nil	Nil	.....	.120	.018	.003	.001	.001	Nil	
	.0010	Nil	.....	.070	.055	.003	.001	Nil	.....	.590	.060	.004	.002	Nil	.....	
	.0010	.0010	.....	.100	.048	.004	.002	.001	.....	.550	.063	.005	.002	Nil	.....	
	.0015	.0005	.....	.140	.038	.008	.002	Nil	.....	.480	.065	.003	.001	.001	.....	
	Nil	.....	.....	.017	.028	.0065	.002	Nil	.....	.365	.030	.011	.005	.001	Nil	
	Nil	.....	.....	.025	.024	.0070	.001	Nil	.....	.320	.024	.018	.003	.001	Nil	
	.0005	.....	.....	.035	.022	.0040	.001	.001	.....	.280	.021	.011	.008	.002	.0005	
	Nil	.....	.....	.025	.027	.0065	.0005	Nil	.....	.340	.038	.002	Nil	.....	.....	
	Nil	.....	.....	.030	.021	.0080	.0020	.001	.....	.320	.036	.002	.0010	.....	.....	
	.0005	.....	.....	.045	.023	.0040	.0010	.001	.....	.290	.029	.008	.0015	.....	.....	

					100 CC DISTILLED.											
LLED WITH P. M. & P.				D	NESSLERIZED DIRECTLY.						E	F EACH REMAINING ½d CC OF P. M. & P.				
10 cc. NH_3	5th 10 cc. NH_3	6th 10 cc. NH_3	Total NH_3	Total NH_3 by b + c.	1st 10 cc. ½d NH_3	2d 10 cc. ½d NH_3	3d 10 cc. ½d NH_3	4th 10 cc. ½d NH_3	5th 10 cc. ½d NH_3	6th 10 cc. ½d NH_3	Total Free NH_3	1st 10 cc. ½d NH_3	2d 10 cc. ½d NH_3	3d 10 cc. ½d NH_3	4th 10 cc. ½d NH_3	5th
0010	Nil	.....	.790	.700	.005	.003	Nil	.....	.....	.....	.160	.007	.005	.001	.....	
0005	Nil	.....	.765	.675	.008	.004	.001	.....	.....	.....	.260	.009	.007	.001	.....	
Nil	Nil	.....	.730	.620	.007	.004	.001	.....	.....	.....	.240	.011	.005	.001	.....	
Nil	Nil	.....	.470	.320	.003	.001	.001	Nil	.....	.....	.100	.006	.0035	.0020	.0005	
0040	.0005	.....	.505	.370	.005	.003	Nil	Nil	.....	.....	.160	.011	.0030	.0010	Nil	
0005	.0005	.....	.480	.330	.004	.002	.001	Nil	.....	.....	.140	.012	.0020	.0005	.0005	
Nil	.....	.....	.370	.220	.002	.001	Nil	Nil	.....	.....	.060	.007	.003	.001	Nil	
.001	.....	.....	.360	.220	.002	.001	Nil	Nil	.....	.....	.060	.007	.003	.001	.0010	
.001	.....	.....	.360	.220	.002	.001	.0005	Nil	.....	.....	.070	.007	.003	.001	.0005	
.007	.002	Nil	3.160	2.555	.046	.017	.005	.0025	.0010	Nil	1.430	.065	.018	.012	.004	
.002	.001	.001	3.430	2.690	.043	.019	.006	.0020	.0010	.001	1.440	.062	.019	.014	.009	
.008	.007	.003	3.820	2.970	.052	.023	.008	.0010	.0010	Nil	1.700	.093	.019	.009	.004	
.001	.001	Nil	1.160	.660	.012	.005	.001	Nil	.....	.....	.360	.026	.011	.004	.0010	
.002	.001	.001	1.130	.670	.015	.004	.001	.0005	.....	.....	.410	.033	.008	.001	Nil	
.004	.002	.001	1.090	.660	.018	.001	.001	Nil	.....	.....	.400	.027	.012	.001	.0005	
.001	Nil	.....	.480	.450	Nil	Nil	Nil	Nil	.....	.....	Nil	.0015	.0005	Nil	Nil	
.001	Nil	.....	.510	.430	Nil	Nil	Nil	Nil	.....	.....	Nil	.0030	.0010	Nil	Nil	
.001	Nil	.....	.520	.430	.001	Nil	Nil	Nil	.....	.....	.020	.0040	.0010	.001	Nil	
.002	Nil	.....	1.740	1.650	.003	.001	Nil	.....	.....	.....	.080	.006	.002	.0010	.....	
.002	Nil	.....	1.740	1.630	.003	.001	.001	.....	.....	.....	.100	.007	.003	.0010	.....	
.003	.0015	.....	1.745	1.630	.003	.002	.001	.....	.....	.....	.120	.008	.003	.0005	.....	
.001	Nil	.....	.140	.110	Nil	Nil	.0005	Nil	Nil	.....	.010	.001	.001	.0005	Nil	
Nil	Nil	.....	.180	.120	Nil	Nil	Nil	Nil	Nil	.....	Nil	.002	.001	Nil	Nil	
.002	Nil	.....	.190	.105	.0005	Nil	Nil	Nil	Nil	.....	.010	.002	.001	.0005	.0005	
Nil	.....	.....	.155	.170	.0010	.0005	Nil	.....	.....	.....	.030	.001	.001	Nil	.....	
Nil	.....	.....	.140	.180	.0010	.0010	Nil	.....	.....	.....	.040	.001	.001	Nil	.....	
Nil	.....	.....	.160	.175	.0015	.0010	.0005	.....	.....	.....	.060	.002	.001	.0005	.....	
.005	Nil	.....	.165	.065	Trace.	Nil	Nil	.....	.....	.....	Trace.	.004	.001	Nil	.....	
Nil	Nil	.....	.160	.060	.0005	Nil	Nil	.....	.....	.....	.010	.005	.001	.0005	.....	
.015	Nil	.....	.175	.075	.0005	Nil	Nil	.....	.....	.....	.010	.005	.001	Nil	.....	
.001	Nil	.....	.180	.135	Trace.	Nil	Nil	.....	.....	.....	Trace.	.0015	.0005	.0005	.....	
Nil	Nil	.....	.180	.130	.0005	Nil	Nil	.....	.....	.....	.010	.0020	.0010	.0005	.....	
.001	Nil	.....	.230	.140	.0010	Nil	Nil	.....	.....	.....	.020	.0030	.0015	.0005	.....	
Nil	.....	.....	.660	.660	.002	.001	Nil	.....	.....	.....	.060	.002	.001	Nil	.....	
Nil	.....	.....	.700	.650	.003	.002	Nil	.....	.....	.....	.100	.006	.001	.001	.....	
.001	.....	.....	.700	.520	.005	.001	.001	.....	.....	.....	.140	.009	.002	Nil	.....	
.001	Nil	.....	.470	.382	.001	Nil	Nil	Nil	.....	.....	.020	.003	.001	.0010	Nil	
.001	Nil	.....	.460	.345	.001	Nil	.0005	Nil	.....	.....	.030	.005	.001	.0005	Nil	
.002	.0005	.....	.425	.315	.001	.001	Nil	Nil	.....	.....	.040	.006	.001	Nil	Nil	
.....	.....	.....	.400	.365	.001	.0005	Nil	Nil	.....	.....	.036	.002	.001	.0005	Nil	
.....	.....	.....	.390	.350	.002	Nil	Nil	Nil	.....	.....	.040	.003	.001	.0005	Nil	
.....	.....	.....	.385	.335	.002	.0005	Nil	Nil	.....	.....	.050	.003	.001	.0010	Nil	

				100 CC DISTILLED.									
TH P. M. & P.			D	NESSLERIZED DIRECTLY.						E	F	EACH REMAINI	
10 cc. NH_3	6th 10 cc. NH_3	Total NH_3	Total NH_3 by b + c.	1st 10 cc. ½d NH_3	2d 10 cc. ½d NH_3	3d 10 cc. ½d NH_3	4th 10 cc. ½d NH_3	5th 10 cc. ½d NH_3	6th 10 cc. ½d NH_3	Total Free NH_3	1st 10 cc. ½d NH_3	2d 10 cc. ½d NH_3	3d 10 cc ½d NH_3
Nil	.....	.790	.700	.005	.003	Nil	.....	.....	.....	.160	.007	.005	.001
Nil	.....	.765	.675	.008	.004	.001	.....	.....	.....	.260	.009	.007	.001
Nil	.....	.730	.620	.007	.004	.001	.....	.....	.....	.240	.011	.005	.001
Nil	.....	.470	.320	.003	.001	.001	Nil	.....	.....	.100	.006	.0035	.0020
0005	.....	.505	.370	.005	.003	Nil	Nil	.....	.....	.160	.011	.0030	.0010
0005	.....	.480	.330	.004	.002	.001	Nil	.....	.....	.140	.012	.0020	.0005
.....	.....	.370	.220	.002	.001	Nil	Nil	.....	.....	.060	.007	.003	.001
.....	.....	.360	.220	.002	.001	Nil	Nil	.....	.....	.060	.007	.003	.001
.....	.....	.360	.220	.002	.001	.0005	Nil	.....	.....	.070	.007	.003	.001
.002	Nil	3.160	2.555	.046	.017	.005	.0025	.0010	Nil	1.430	.065	.018	.012
.001	.001	3.430	2.690	.043	.019	.006	.0020	.0010	.001	1.440	.062	.019	.014
.007	.003	3.820	2.970	.052	.023	.008	.0010	.0010	Nil	1.700	.093	.019	.009
.001	Nil	1.160	.660	.012	.005	.001	Nil	.....	.....	.360	.026	.011	.004
.001	.001	1.130	.670	.015	.004	.001	.0005	.....	.....	.410	.033	.008	.001
.002	.001	1.090	.660	.018	.001	.001	Nil	.....	.....	.400	.027	.012	.001
Nil	.....	.480	.450	Nil	Nil	Nil	Nil	.....	.....	Nil	.0015	.0005	Nil
Nil	.....	.510	.430	Nil	Nil	Nil	Nil	.....	.....	Nil	.0030	.0010	Nil
Nil	.....	.520	.430	.001	Nil	Nil	Nil	.....	.....	.020	.0040	.0010	.001
Nil	.....	1.740	1.650	.003	.001	Nil	.....	.....	.....	.080	.006	.002	.0010
Nil	.....	1.740	1.630	.003	.001	.001	.....	.....	.....	.100	.007	.003	.0010
0015	.....	1.745	1.630	.003	.002	.001	.....	.....	.....	.120	.008	.003	.0005
Nil	.....	.140	.110	Nil	Nil	.0005	Nil	Nil	.....	.010	.001	.001	.0005
Nil	.....	.180	.120	Nil	Nil	Nil	Nil	Nil	.....	Nil	.002	.001	Nil
Nil	.....	.190	.105	.0005	Nil	Nil	Nil	Nil	.....	.010	.002	.001	.0005
.....	.....	.155	.170	.0010	.0005	Nil	.....	.....	.....	.030	.001	.001	Nil
.....	.....	.140	.180	.0010	.0010	Nil	.....	.....	.....	.040	.001	.001	Nil
.....	.....	.160	.175	.0015	.0010	.0005	.....	.....	.....	.060	.002	.001	.0005
Nil	.....	.165	.065	Trace.	Nil	Nil	.....	.....	.....	Trace.	.004	.001	Nil
Nil	.....	.160	.060	.0005	Nil	Nil	.....	.....	.....	.010	.005	.001	.0005
Nil	.....	.175	.075	.0005	Nil	Nil	.....	.....	.....	.010	.005	.001	Nil
Nil	.....	.180	.135	Trace.	Nil	Nil	.....	.....	.....	Trace.	.0015	.0005	.0005
Nil	.....	.180	.130	.0005	Nil	Nil	.....	.....	.....	.010	.0020	.0010	.0005
Nil	.....	.230	.140	.0010	Nil	Nil	.....	.....	.....	.020	.0030	.0015	.0005
.....	.....	.660	.660	.002	.001	Nil	.....	.....	.....	.060	.002	.001	Nil
.....	.....	.700	.650	.003	.002	Nil	.....	.....	.....	.100	.006	.001	.001
.....	.....	.700	.520	.005	.001	.001	.....	.....	.....	.140	.009	.002	Nil
Nil	.....	.470	.382	.001	Nil	Nil	Nil	.....	.....	.020	.003	.001	.0010
Nil	.....	.460	.345	.001	Nil	.0005	Nil	.....	.....	.030	.005	.001	.0005
005	.....	.425	.315	.001	.001	Nil	Nil	.....	.....	.040	.006	.001	Nil
.....	.....	.400	.365	.001	.0005	Nil	Nil	.....	.....	.036	.002	.001	.0005
.....	.....	.390	.350	.002	Nil	Nil	Nil	.....	.....	.040	.003	.001	.0005
.....	.....	.385	.335	.002	.0005	Nil	Nil	.....	.....	.050	.003	.001	.0010

PARTS PER LITRE.

TILLED.								Dr. Leed's G New Method.		H Dissolved Gases in 100 cc.			
ach Remaining ½d cc of E Separately Re-Distilled with 1 cc P. M. & P. and 10 cc Water.													
10 cc. ½d NH_3	3d 10 cc. ½d NH_3	4th 10 cc. ½d NH_3	5th 10 cc. ½d NH_3	6th 10 cc. ½d NH_3	Free NH_3 + Bol. NH_2.	Free NH_3 + Bol. NH_2 less Free NH_3 of e.	Bol. Nitrog. Matter by d (b & c).	Silver Reduced Mgms.	Oxygen Equivalent to Silver Reduced.	Carbonic Acid. C. C.	Oxygen. C. C.	Nitrogen, etc. C. C.	Total C. C.
.005	.001	.....	.....	.....	.260	.100	.090	21.7	3.12	24.4	1.7	10.3	36.4
.007	.001	.....	.....	.....	.340	.080	.090	18.2	2.69	26.2	.9	9.3	35.4
.005	.001	.....	.....	.....	.340	.100	.110	17.8	2.64	26.4	2.3	11.1	39.8
.035	.0020	.0005	.....	.....	.240	.140	.150	13.0	1.92	3.62	2.4	13.6	52.2
.030	.0010	Nil	.....	.....	.300	.140	.135	10.4	1.54	3.81	2.0	10.2	50.3
.020	.0005	.0005	.....	.....	.300	.160	.150	9.0	1.33	3.86	3.2	14.3	56.1
.003	.001	Nil	.....	.....	.220	.160	.150	20.7	3.07	26.4	3.2	16.2	45.8
.003	.001	.0010	.....	.....	.240	.180	.140	20.3	3.01	27.1	3.1	15.6	45.8
.003	.001	.0005	.....	.....	.230	.160	.140	19.9	2.95	27.4	3.6	16.4	47.4
.018	.012	.004	.0020	.0005	2.030	.600	.605	32.8	5.41	39.7	.6	11.4	51.7
.019	.014	.009	.0040	.0005	2.170	.730	.740	30.9	4.58	39.8	.4	11.6	51.8
.019	.009	.004	.0015	.0005	2.540	.840	.850	30.6	4.53	41.3	1.1	10.9	53.3
.011	.004	.0010	.....	.....	.840	.480	.500	22.3	3.30	42.1	1.3	9.6	53.0
.008	.001	Nil	.....	.....	.840	.430	.460	21.8	3.23	42.2	2.1	11.2	55.5
.012	.001	.0005	.....	.....	.810	.410	.430	20.2	2.99	43.8	3.2	11.4	58.4
.005	Nil	Nil	.....	.....	.040	.040	.030	10.0	1.48	26.4	4.3	14.8	45.5
.010	Nil	Nil	.....	.....	.080	.080	.080	9.1	1.35	25.2	4.8	12.6	42.6
.010	.001	Nil	.....	.....	.120	.100	.090	9.6	1.42	26.9	5.1	11.4	43.4
.002	.0010	.....	.....	.....	.180	.100	.090	9.6	1.42	41.0	2.4	14.2	57.6
.003	.0010	.....	.....	.....	.220	.120	.110	9.3	1.38	42.1	3.2	13.6	58.9
.003	.0005	.....	.....	.....	.230	.110	.115	9.4	1.39	43.6	3.1	14.2	60.9
.001	.0005	Nil	Nil	.....	.050	.040	.030	6.3	.93	32.4	3.6	11.8	47.8
.001	Nil	Nil	Nil	.....	.060	.060	.060	6.1	.90	33.1	4.4	11.9	49.4
.001	.0005	.0005	Nil	.....	.080	.070	.085	5.0	.74	34.6	4.6	10.4	49.6
.001	Nil	.....	.....	.....	.040	.010	.015	13.6	2.01	29.7	3.4	14.6	47.7
.001	Nil	.....	.....	.....	.040	Nil	.040	12.9	1.91	30.2	3.6	11.9	45.7
.001	.0005	.....	.....	.....	.070	.010	.015	11.7	1.72	29.7	3.9	12.2	45.8
.001	Nil	.....	.....	.....	.100	.100	.095	4.3	.64	32.6	4.4	13.6	50.6
.001	.0005	.....	.....	.....	.130	.120	.100	4.1	.61	34.2	4.8	11.6	50.6
.001	Nil	.....	.....	.....	.120	.110	.100	3.6	.52	35.0	5.1	11.8	51.9
.005	.0005	.....	.....	.....	.050	.050	.045	13.9	2.06	37.4	2.1	14.3	53.8
.010	.0005	.....	.....	.....	.070	.060	.050	12.6	1.86	39.3	4.0	11.6	54.9
.015	.0005	.....	.....	.....	.100	.080	.090	13.2	1.96	39.4	3.9	11.7	55.0
.001	Nil	.....	.....	.....	.060	Nil	Nil	26.0	3.85	34.2	1.6	9.7	45.5
.001	.001	.....	.....	.....	.160	.060	.050	28.6	4.24	35.4	2.1	11.2	38.7
.002	Nil	.....	.....	.....	.220	.080	.080	23.2	3.44	35.8	2.6	10.2	38.6
.001	.0010	Nil	.....	.....	.100	.080	.088	15.2	2.25	32.3	1.4	11.6	45.3
.001	.0005	Nil	.....	.....	.130	.100	.115	15.8	2.34	34.2	2.0	11.4	47.6
.001	Nil	Nil	.....	.....	.140	.100	.110	14.8	2.19	34.9	2.3	11.8	49.0
.001	.0005	Nil	.....	.....	.070	.040	.035	10.6	1.57	28.4	3.1	10.8	42.3
.001	.0005	Nil	.....	.....	.090	.050	.040	11.4	1.67	30.0	3.6	11.2	44.8
.001	.0010	Nil	.....	.....	.100	.050	.050	10.9	1.61	30.8	4.1	11.2	46.1

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A DICTIONARY OF THE ACTION OF HEAT UPON CERTAIN METALLIC SALTS,

INCLUDING AN INDEX TO THE PRINCIPAL LITERATURE UPON THE SUBJECT.

COMPILED AND ARRANGED BY J. W. BAIRD, M. A., PH. C.

CONTRIBUTED BY PROF. A. B. PRESCOTT.

INTRODUCTION.

It has been the aim of the author, in compiling the present work, to place in convenient form a fairly complete, and yet a concise, statement of the effect of heat upon metallic salts. No original experiments were made, nor anything introduced except that which could be accompanied by good authority. The works consulted comprise the leading journals of the present century and such works of reference as Gmelin-Kraut, Watts' Dictionary, etc., in all about 1200 volumes. Absolute completeness cannot be claimed, for such a claim could only be based upon exhaustive research through all the scientific works extant, a thing which in this case was utterly impossible; but comprising as it does a review of so many volumes, that represent the majority of experiments performed in the scientific world, it cannot be otherwise than practically complete.

Brevity has always been one of the objects held in view, and if in any case a more minute statement is desired, the authority itself can then be consulted, which in every instance accompanies the subject matter. Not only is reference to the original article given, which is always placed first, but also references to the briefs or abstracts of that article, care being taken to give accurately the volume and page.

There will be found given the melting and boiling points of the salts, the temperature at which disassociation takes place, the products of decomposition, both volatile and residual, and such other facts as fall within the scope of the subject, only just so far as these things are stated by the authorities consulted.

To all those who may have occasion to refer to this work, either for practical, chemical, or in short for any scientific purpose whatever, it is respectfully submitted.

J. W. BAIRD,

University, Ann Arbor, Mich., 1883.

LIST OF WORKS CONSULTED.

Annalen der Chemie und Pharmacie and Supplements, from 1843 to 1881.

Annalen der Physik und Chemie, by J. C. Poggendorff, from 1824 to 1880.

Annales de Chemie et de Physique, from 1816 to 1880

American Chemist, from 1870 to 1876.

American Journal of Pharmacy from 1848 to 1880.

Berichte der Deutschen Chemischen Gesellschaft zu Berlin, from 1868 to 1880.

Chemical News, London, 1860 to 1882.

Chemical Gazette, London, 1842 to 1859.

Comtes rendus, Paris, 1857 to 1881.

Edinburgh Philosophical Journal, 1819 to 1824.

Gmelin-Kraut's Handbuch der Chemie, for all the salts except those of NH_4, Sb, As, and Bi, for which was used

Gmelin's Handbuch der Chemie, translated by Watts.

Jahresbericht über die Fortschritte der Chemie, 1847 to 1879 except 1863 and 1864.

Jahresbericht über die Fortschritte der Pharmacognosie, Pharmacie und Toxicologie, 1866 to 1880.

Journal für praktische Chemie, 1834 to 1881.

Journal of the Chemical Society of London, 1849 to 1881.

Miller's Inorganic Chemistry.

Philosophical Magazine and Journal of Science, 1832 to 1882.

Proceedings of the Royal Society of London, 1856 to 1879.

Abstracts of the papers printed in the Philosophical transactions of the Royal Society of London, 1800 to 1855.

Roscoe and Schorlemmer's Treatise on Chemistry.

Watts' Dictionary of Chemistry with supplements.

Zeitschrift für Analytische Chemie, 1862 to 1881.

EXPLANATORY NOTES.

The salts that are taken under consideration are the bromides, chlorides, iodides, nitrates, nitrites, phosphates, sulphates, sulphides, and sulphites, including only those of the common bases, viz., Al, NH^{iv}, Sb^{iii}, Sb^{v}, As^{iii}, As^{v}, Ba, Bi^{iii}, Cd, Ca, Cr^{iii}, Co^{ii}, Cu^{i}, Cu^{ii}, Fe^{ii}, Fe^{iii}, Pb, Mg, Mn^{ii}, Mn^{iii}, Hg^{i}, Hg^{ii}, Ni^{ii}, K, Na, Ag, Sn^{ii}, Sn^{iv}, Sr, Zn, and that too only the normal salts, except in the case of the phosphates, where the mono-, di-, and tri-basic salts are given.

The temperatures are given on the Centigrade scale, excepting when the contrary is expressly stated.

The following is the list of the most important abbreviations :

Abstracts Phil. Trans. of Roy. Soc.—Abstracts of the Philosophical Transactions of the Royal Society.

Amer. Chem.—American Chemist.

Amer. J. Pharm.—American Journal of Pharmacy.

Amer. J. Sci.—American Journal of Science.

Annalen.—Annalen der Chemie und Pharmacie.

Ann. Chim. Phys.—Annales de Chimie et de Physique.

Ann. Chim.—Annales de chimie.

Arch. der Pharm.—Archiv der Pharmacie.

Arch. ne'-erland.—Archives ne'-erlandaises des Sciences.

Ber.—Berichte der deutschen chemischen Gesellschaft zu Berlin.

Berzelius Jahresb.—Jahresbericht über die Fortschritte der physichen Wissenschaften, oder der Chemie und Mineralogie. Jacob Berzelius.

Bull Soc. chim.—Bulletin de la société chimique de Paris.

Br. Arch.—Archiv des Apothekervereins im nördlichen Deutschland.

Chem. Centr.—Chemisch-Pharmaceutisches, since 1857 Chemisches Centralblatt.

Chem. Gaz.—Chemical Gazette.

Chem. News.—Chemical News.

Chem. Soc. J.—Journal of the Chemical Society.

Compt. rend.—Comptes rendus hebdomadaires, des Séances de l' Academie des Sciences. Paris.

Crell. Ann.—Chemische Annalen by Dr. Crell.

Dingl. Pol. J.—Polytechnisches Journal. by E. M. Dingler.

Ed. Phil. J.—Edinburgh Philosophical Journal.

Gilb. Ann.—Annalen der Physik, afterwards der Physik und physikalischen Chemie, by L. W. Gilbert.

Gmelin-Kraut.—Gmelin's Handbuch by Kraut.

Gmelin. Watts' Transl.—Gmelin's Handbuch, translated by Watts.

Institut.—L' Institut, Paris.

Jahresb.—Jahresbericht für die Fortschritte der Chemie, Physik, Mineralogie und Geologie.

Jahresb. Ph. Tox.—Jahresbericht über Fortschritte der Pharmacognosie, Pharmacie und Toxicologie.

J. Chim. méd.—Journal de chimie médicale de pharmacie.

J. Ph. Chim.—Journal de Pharmacie et de chimie.

J. pr. Chem.—Journal für praktische Chemie.

Miller.—Miller's Inorganic Chemistry.

Mag. der Pharm.—Magazin der Pharmacie.

Mem. and Proc. Chem. Soc.—Memoirs and Proceedings of the Chemical Society.

Mulhouse Soc. Bull.—Bulletin de la société industrielle de Mulhouse.

N. Gehl.—Journal für die Chemie und Physik by A. F. Gehlin.

N. Jahrb. Pharm.—Neues Jahrbuch für Pharmacie.

Pharm. Centr.—See Chem. Centr.

Pharm. J. Trans.—Pharmaceutical Journal and Transactions.

Phil. Mag. J.—Philosophical Magazine and Journal of Science.

Phil. Trans.—Philosophical Transactions.

Ph. Ch. Ber.—Philos. der Chemie. Berlin.

Pogg. Ann.—Annalen der Physik und Chemie. J. C. Poggendorff.

Proc. Amer. Acad.— Proceedings of the American Academy of Arts and Sciences.

Proc. Roy. Soc.—Proceedings of the Royal Society.

Rep. Ch. appli.—Repertoire de Chimie appliquée.

Rep. Ch. pure.—Repertoire de Chimie pure.

Ros. and Sch.—Roscoe and Schorlemmer's Chemistry.

Schw.—Journal für Chemie und Physik by Dr. S. C. Schweigger.

Tech. Jahr.—Jahresbericht über die Fortschritte der chemischen Technologie.

Trans. Roy. Soc. Ed.—Transactions of the Royal Society of Edinburgh.

Watts' Dict.—Watts' Dictionary of Chemistry.

Wiss. Acad. Ber.—Sitzungsberichte der k. k. Akademie der Wissenschaften.

Zeitschr. Anal. Chem.—Zeitschrift für analytische Chemie.

Zeitschr. Chem.—Zeitschrift für Chemie.

Zeitschr. Chem. Pharm.—Zeitschrift für Chemie und Pharmacie.

THE BROMIDES.

Aluminium Bromide. Al_2Br_6.

Aluminium bromide melts at 90°, Rud. Weber (1) or at 93°, Deville and Troost (2), to a clear mobile liquid, which boils at 265–270°, Rud. Weber (1), or at 260°, Deville and Troost (2). When heated in sealed tubes it sublimes, forming colorless glittering laminæ, Rud. Weber (3); but when heated in the air it decomposes into hydro-bromic acid and aluminium oxide, Berthemot, (4) or into vapor of bromine and oxide of aluminium, Rud. Weber (5).

Ammonium Bromide. NH_4Br.

Ammonium bromide vaporizes in the heat without previous fusions (6).

Antimonous Bromide. $SbBr_3$.

Antimonous bromide melts at 90°, Kopp (1), R. W. Emerson MacIvor (2), at 93°, J. P. Cook (3), at 94°, H. Serullas (4), or at 95° (5) to a pale greenish-yellow colored liquid, which boils at or near 283°, R. W. Emerson MacIvor (2), at 270°. H Serullas (6), at 275.4°, Kopp (7), or at 280°, J. P. Cook (3). When heated in a closed vessel it sublimes unchanged, H. Serullas (8).

Arsenious Bromide. $AsBr_3$.

Arsenious bromide melts at 20–25° to a pale yellow liquid which boils at 220°, H. Serullas (9), and on cooling congeals in long prisms. When heated in closed vessels it sublimes unchanged, H. Serullas (10).

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(1) Pogg. Ann. 103. 259. J. pr. Chem. 74. 165. Chem. Gaz. 16. 269. Chem. Centr. 1858. 365. Jahresb. 10. 157. Gmelin-Kraut. 2. 1. 642. Watts Dict. 1. 156. Ros. and Sch. 2. 1. 447. (2) Jahresb. 12. 26. (3) Pogg. Ann. 103. 259. J. pr. Chem. 74. 165. Chem. Gaz. 16. 269. Ros. and Sch. 2. 1. 447. (4) Ann. Chim. Phys. 44. 394. (5) Pogg. Ann. 103. 266. Chem. Gaz. 16. 269. Chem. Centr. 1858. 365. Jahresb. 10. 157. Gmelin-Kraut. 2. 1. 642. Watts Dict. 1. 156. (6) Gmelin. Watts Translation, 2. 469.

(1) Annalen 95. 307. Pharm. Centr. 1855. 771. Jahresb. 8. 37. (2) Chem. News 29. 179. (3) Proceed. Amer. Acad. New Series 5. Ber. 11. 255. Jahresb. Ph. Tox. 1878. 259. Jahresb. 30. 284. (4) Pogg. Ann. 14. 111. Ann. Chim. Phys. 38. 322. (5) Ros. and Sch. 2. 2. 319. (6) Pogg. Ann. 14. 111. Ann. Chim. Phys. 38. 322. Gmelin, Watts Translation, 4. 364. Watts Dict., 1. 317. (7) Annalen. 95. 307. Pharm. Centr. 1855. 771. Jahresb. 8. 37. Ros. and Sch. 2. 2. 319. (8) Pogg. Ann. 14. 111. Ann. Chim. Phys. 38. 322. Ros. and Sch. 2. 2. 319. (9) Pogg. Ann. 14. 111. Ann. Chim. Phys. 38. 320. Gmelin, Watts Transl. 4. 283. Watts Dict., 1. 371. Ros. and Sch. 1. 523. Miller 586. (10) Pogg. Ann. 14. 111. Ann. Chim. Phys. 38. 320. Gmelin. Watts Transl. 4. 283.

Barium Bromide. $BaBr_2$.

Anhydrous barium bromide melts at 812°, T. Carnelley (1). The salt crystallized with 2 mol. water melts when heated, Balard (2), and loses its water, C. Rammelsberg (3).

Bismuth Bromide. $BiBr_3$.

Bismuth bromide melts at 198–200°, R. W. E. MacIvor (4), at 200°, H. Serullas (5), or at 210–215°, M. P. Muir (6), to a hyacinth red liquid, which boils at a dark red heat, H. Serullas (5), R. W. E. MacIvor (4) or at 454–498° T. Carnelley and W. C. Williams (7). The salt can be sublimed unchanged, H. Serullas (8).

Cadmium Bromide. $CdBr_2\ 4H_2O$.

Crystallized cadmium bromide loses ½ its water at 100° and the other ½ at 200° without undergoing fusion, C. Rammelsberg (9); but when rapidly heated, it melts in its water of crystallization, becomes anhydrous and if the temperature be now raised to almost redness it entirely sublimes in the form of round pearly white scales, Berthemot (1). The anhydrous salt melts at 571°, T. Carnelley (2).

Calcium Bromide. $CaBr_2$.

Calcium bromide melts at 676°, T. Carnelley (3), at 680°, T. Carnelley (2) or at a strong red heat under separation of Bromine (4).

Chromium Bromide. Cr_2Br_6.

Chromium bromide decomposes when it is heated in the air, and leaves the green oxide of Chromium behind, Wöhler (5), Berthemot (6), Wöhler and Bauck (7).

Cobaltous Bromide. $CoBr_2\ 6H_2O$.

The crystallized cobaltous bromide fuses at 100°, loses water, and is found on cooling to be a mass of purplish-blue crystals covered with a blue opaque crust of $CoBr_2\ 2H_2O$; while at 130° the salt dries

(1) Chem. Soc. J. 33. 279. (2) Pogg. Ann. 8. 330. (3) Pogg. Ann. 55. 237. (4) Chem. Soc. J. 28. 133. Chem. News. 30. 190. (5) Pogg. Ann. 14. 111. Ann. Chim. Phys. 38. 318. Watts Dict. 1. 591. (6) Chem. Soc. J. 29. 144. Chem. News. 32. 277. Ros. and Sch. 2. 2. 337. (7) Chem. Soc. J. 33. 281. (8) Pogg. Ann. 14. 111. Ann. Chim. Phys. 38. 318. (9) Pogg. Ann. 55. 241, Gmelin-Kraut 3. 71. Watts Dict. 1. 703.

(1) Ann. Chim. Phys. 44. 388. Gmelin-Kraut 3. 71 (2) Chem, Soc. J. 33. 273. (3) Chem. Soc. J. 29. 489. Zeitschr. Anal. Chem. 17. 469. (4) Gmelin-Kraut 2. 1. 393. (5) Annalen 111. 383. Phil. Mag. J. (4) 18. 456. Gmelin-Kraut 2. 2. 313. (6) Ann. Chim. Phys. 44. 383. Gmelin-Kraut 2. 2. 313. (7) J. Ph. Chim. 1859. Chem. News. 1. 82.

to an opaque amorphous vivid green mass, consisting of the anhydrous salt, Walter Noel Hartley (1). When heated it leaves a bluish-green residue of the anhydrous salt, C. Rammelsberg (2), which melts at a strong red heat under some decomposition, Berthemot (3).

Cupric Bromide. $CuBr_2$.

Cupric bromide loses ½ its bromine even below a red heat and is thereby changed into cuprous bromide, Berthemot (4), C. Rammelsberg (5), (6).

Cuprous Bromide. Cu_2Br_2.

Cuprous bromide melts at a red heat, does not volatilize when heated in closed vessels, and only with difficulty in the air, Löwig (7). It will withstand a strong heat in a closed tube without decomposition, while in a crucible in contact with the air, it volatilizes in vapors which color the flame green and leaves a residue of cupric oxide behind, Berthemot (8). The salt decomposes by ignition in the air* (1).

Ferric Bromide. Fe_2Br_6.

Ferric bromide, when heated in absence of air, fuses and part may be sublimed without decomposition, another portion however being decomposed into ferrous bromide and free bromine (2).

Ferrous Bromide. $FeBr_2$.

When ferrous bromide is heated to redness in contact with air, ferric bromide sublimes and ferric oxide is left as a residue, Löwig, (3). If the salt be reduced to a powder, put in a tube and heated to redness, it volatilizes; and when the temperature is raised still higher a little decomposes with the formation of vapors of bromine, Berthemot (4).

Lead Bromide. $PbBr_2$.

Lead Bromide melts at 499°, T. Carnelley (5) or at a strong heat to a red liquid, Balard (6), which, when the air is excluded, solidi-

*(1) Chem, Soc. J. 27. 501. Chem. News. 29. 161. Jahresb. 74. 273. Ross and Sch. 2. 2. 130. (2) Pogg. Ann. 55. 244. Gmelin-Kraut 3. 455. Ros. and Sch. 2. 2. 130. (3) Ann. Chim. Phys. 44. 391. Gmelin-Kraut 3. 455. Watts Dict. 1. 1042. (4) Ann, Chim. Phys. 44. 387. Gmelin-Kraut 3. 638. Watt. Dict. 2. 52. (5) Pogg. Ann. 55. 246. Gmelin Kraut 3. 638. Watts Dict. 2. 52. (6). Ros. and Sch. 2. 1. 336. (7) Gmelin-Kraut 3. 638. (8) Ann. Chim. Phys. 44. 385. Gmelin-Kraut 3. 638.

†(1) Watts Dict. 2. 52. (2) Gmelin-Kraut 3. 353. Ros. and Sch. 2. 2. 100. (3) Gmelin-Kraut 3. 352. (4) Ann. Chim. Phys. 44. 392. (5) Chem.Soc. J. 33. 273. (6) Pogg. Ann. 8. 330. Gmelin-Kraut 3. 345. Ros. and Sch. 2. 1. 287.

fies to a white horny mass, Löwig (7); but by fusion in the air it emits white fumes and leaves a pearly yellow residue of the oxybromide, Balard* (1).

Magnesium Bromide. $MgBr_2$.

Anhydrous magnesium bromide melts at 695°, T. Carnelley (2) or is not fusible below a red heat and is not volatile, H. Serullas (3). The crystallized salt ($MgBr_2.6H_2O$) is decomposed when heated in the air into hydro-bromic acid and oxide of magnesium, Balard (4).

Manganous Bromide. $MnBr_2$.

Crystallized manganous bromide ($MnBr_2\ 2H_2O$), when carefully heated in a closed vessel, gives off its water of crystallization and leaves the anhydrous bromide (5), and this when ignited in contact with the air, gives off bromine vapors and leaves manganoso-manganic oxide (6). The salt containing 4 mol. of water ($MnBr_2\ 4H_2O$) melts in its water of crystallization when heated, and then becomes anhydrous, melting again at a white heat, at which temperature it decomposes completely in contact with the air into bromine and oxide of manganese. Berthemot† (1).

Mercuric Bromide. $HgBr_2$.

Mercuric bromide melts at 222–223°, Oppenheim (2) or at 244°, T. Carnelley (3), and sublimes, Balard (4), Löwig (5) (6), boiling at 319°, T. Carnelley and W. C. Williams (7).

Mercurous Bromide. Hg_2Br_2.

Mercurous bromide is fusible, O. Henry (8), or is not fusible, and volatilizes undecomposed at 405°, T. Carnelley (3) or at a low red heat, Löwig (9).

Nickelous Bromide. $NiBr_2$.

Nickelous bromide, when heated to strong redness out of contact

Miller 638. (7) Gmelin-Kraut 3. 245. Watts Dict. 3. 538. Ros. and Sch. 2. 1. 287.

* (1) Pogg. Ann. 8. 330. Gmelin-Kraut 3. 245. Watts Dict. 3. 538. Ros. and Sch. 2. 1. 287. (2) Chem. Soc. J. 33. 273. (3) Ann. Chim. Phys. 48. 87. Pogg. Ann. 24. 343. J. Chim. med. 8. 4. Gmelin-Kraut 2. 1. 466. (4) Pogg. Ann. 8. 330. Gmelin-Kraut 2. 1. 466. Watts Dict. 3. 752. Ros. and Sch. 2 1. 242. (5) Watts Dict. 3. 803. (6) Gmelin-Kraut 2, 2. 493.

† (1) Ann. Chim. Phys. 44. 392. Gmelin-Kraut 2. 2. 493. (2) Clark's Constants of Nature. (3) Chem. Soc. J. 33. 273. (4) Pogg. Ann. 8. 331. Gmelin-Kraut 3, 778. Watts Dict. 3. 892. (5) Gmelin-Kraut 3. 778. (6) Ros. and Sch. 2. 1. 405. (7) Chem. Soc. J. 33. 281. (8) J. Ph. Chim. 15. 56. Gmelin-Kraut 3. 778. Watts Dict. 3. 892. (9) Gmelin-Kraut 3. 778. Watts Dict. 3.

with air, sublimes in golden scales; but if air be admitted it decomposes into bromine vapor and nickelous oxide, Berthemot (10). The crystallized salt ($NiBr_2 3H_2O$) loses its water at 200°, C. Rammelsberg* (1).

Potassium Bromide KBr.

Potassium bromide decrepitates in the fire, Balard (2), melts at 699°, T. Carnelley (3), or at 703°, T. Carnelley (4), without decomposition, Balard (2), and solidifies again at 685°, T. Carnelley (5).

Silver Bromide AgBr.

Silver bromide melts at 380, G. F. Rodwell (6), at 427°, T. Carnelley (3), or at 434°, T. Carnelley (4) to a reddish liquid, which on cooling congeals to a yellow translucent horny mass, Balard (7).

Sodium Bromide NaBr.

Sodium bromide melts at 708°, T. Carnelley (3), or, at 712°, T. Carnelley (4). The crystallized salt ($NaBr\ 2H_2O$) melts in the heat, losing its water and becoming anhydrous, Mitscherlich (8).

Stannic Bromide. $SnBr_4$.

Stannic bromide melts easily, Balard† (1), at 30°, and boils without decomposition at 201° (uncorr), at which temperature it sublimes, T. Carnelley and L. T. O'Shea (2), in the form of needles (3); but at a gentle heat in the air it gives off white vapors, Balard (4), which consist of the oxide of tin, T. Carnelley and L. T. O'Shea (5).

Stannous Bromide. $SnBr_2$.

Stannous bromide melts at 259°, T. Carnelley and W. C. Williams (6), to a yellowish oily liquid (3), which boils at 617-634°, T. Carnelley and W. C. Williams (6). When the salt is heated in the air it evolves stannic bromide and leaves stannic oxide behind (3).

Strontium Bromide. $SrBr_2$.

Strontium bromide melts at 630°, T. Carnelley (7), or at a red

892. Ros. and Sch. 2. 1. 400. (10) Ann. Chim. Phys. 44.382. J. Ph. Chim. 16. 655. Gmelin-Kraut, 3. 552. Ros. and Sch. 2. 2. 150.

* (1) Pogg. Ann. 55.343. (2) Pogg. Ann. 8.327. Gmelin-Kraut, 2. 2. 69. Watts Dict. 4. 696. (3) Chem. Soc. J. 33. 273. (4) Chem. Soc. J. 29. 489. Zeitsch. Anal. Chem. 17. 469. (5) Chem. Soc. J. 29. 499. (6) Proc. Roy. Soc. 25. 280. (7) Pogg. Ann. 8. 332. Gmelin-Kraut 3. 936. Ros. and Sch. 2. 1. 373. (8) Pogg. Ann. 17. 385. Gmelin-Kraut. 2. 1. 202.

† (1) Pogg. Ann. 8. 331. Gmelin-Kraut 3. 124. Watts Dict. 5. 806. (2) Chem. Soc. J. 33. 56. Ros. and Sch. 2. 2. 249. (3) Gmelin-Kraut 3. 124. Watts Dict. 5. 808. (4) Pogg. Ann. 8. 331. Gmelin-Kraut 3. 124. (5) Chem. Soc. J. 33. 56. (6) Chem. Soc. J. 35. 563. Ber. 12. 1360. (7) Chem. Soc. J.

heat without decomposition, Berthemot (8), C. Rammelsberg (9). The crystallized salt ($SrBr_2 6H_2O$), when heated, melts without decomposition in its water of crystallization, C. Rammelsberg* (1) Berthemot (2), which it loses at a gentle heat, Löwig (3).

Zinc Bromide. $ZnBr_2$.

Zinc bromide melts at 394°, T. Carnelley (4), to a yellow liquid, Löwig (5), which boils at 695-699°, T. Carnelley and W. C. Williams (6), and sublimes in the form of white needles, Löwig (7), or passes over in the form of white vapors, Berthemot (8).

THE CHLORIDES.

Aluminium Chloride. Al_2Cl_6.

Aluminium chloride in small quantities volatilizes in the heat without melting ; a large amount, however, when strongly and rapidly heated, melts and then boils, the vapors condensing between 180 and 185°, Liebig† (1). The salt is fusible, F. Wöhler (2), boils at 180-185°, (Liebig) Weber (3), and its point of volatility seems to coincide with its melting point, Wöhler (4), or is not much higher than the boiling point of water, (Oersted) Wöhler (2). The crystallized salt containing 12 mol. of water ($Al_2 Cl_6 12H_2O$) loses when heated, water and hydrochloric acid without previously undergoing fusion, and leaves a residue of aluminium oxide, v. Bonsdorff (5.)

Ammonium Chloride. NH_4Cl.

Ammonium chloride, when heated, volatilizes undecomposed without previous fusion (6), forming after sublimation white crystalline masses (7), or a fibrous mass of crystalline structure, J. M. Maisch (8). The salt is decomposed on vaporization, L. Pebal

33. 275. (8) Ann. Chem. Phys. 44. 395. Gmelin-Kraut 2. 1. 334. Watts Dict. 5. 436. (9) Pogg. Ann. 55. 238. Gmelin-Kraut 2. 1. 334. Watts Dict. 5. 436.

* (1) Pogg. Ann. 55. 238. Gmelin-Kraut 2. 1. 334. Watts Dict. 5. 436. (2) Ann. Chim. Phys 44. 395. (3) Mag. der Pharm. 33. 7. Gmelin-Kraut 2. 1. 334. (4) Chem. Soc. J. 33. 273. (5) Gmelin-Kraut 3. 29. (6) Chem. Soc. J. 33. 281. Chem. News. 37. 212. Dingl. polyt. J. 230 449. Jahresb. 31. 36. (7) Gmelin-Kraut 3. 29. Watts Dict. 5. 1069. Ros. and Sch. 2. 1. 261. (8) Ann. Chim. Phys. 44. 389.

† (1) Annalen 17. 43. Gmelin-Kraut 2. 1. 644. Watts Dict. 1. 157. Ros. and Sch. 2. 1. 447. (2) Pogg. Ann. 11. 151. (3) Pogg. Ann. 103. 259. Chem. Gaz. 16. 269. (4) Pogg. Ann. 11. 150. Miller 429. (5) Pogg. Ann. 27. 279. Gmelin-Kraut 2. 1. 644. Ros. and Sch. 2. 1. 447. (6) Gmelin, Watts Transl. 2, 478· Watts Dict. 1. 191. Miller 392. (7) Watts Dict. 1. 191. (8) Amer J.

(9),or is not decomposed, Deville (10). When the salt is heated in a bright platinum dish, it volatilizes without browning and without leaving a residue, Karl Seubert (1).*

Antimonic Chloride. $SbCl_5$.

Antimonic chloride solidifies only in a freezing mixture, forming needle-shaped crystals, which melt, at —6°, F. Kammerer (2), volatilize easily, and which on distillation partially decompose into chlorine and antimonous chloride (3).

Antimonous Chloride. $SbCl_3$.

Antimonous chloride melts at 72°, J. P. Cooke (4), Capitaine (5), or at 73.2°, Kopp (6), boils at 197.8°, Davy (7), at 200° (8), at 216° J. P. Cooke (9), at 221° T. Carnelley and W. C. Williams (10), at 223°, Kopp (11), or at 230° Capitaine (12), and can be distilled in a retort at a temperature above that required to distill hydrochloric acid (1).†

Arsenious Chloride. $AsCl_3$.

Arsenious chloride does not solidify even at —29°, J. Davy (2), and boils at 128°, Haagen (3), at 130.21°, T. E. Thorpe (4), at 132°, Dumas (5), or at 134°, Pierre (6).

Barium Chloride. $BaCl_2 2H_2O$.

Crystallized barium chloride with 2 mol. of water loses 1 mol.

Pharm. 32. 522. Chem. News. 3. 96. (9) Amer J. Pharm. 30. 54. Ros. and Sch. 2. 1. 176 (10) Jahresb. 16. 37. Ros. and Sch. 2. 1. 176.

*(1) Annalen. 207. 10. (2) Ber. 8. 517. Amer. Chem. 6. 112. Ros. and Sch. 2. 2, 318. (3) Ros. and Sch. 2. 2. 318. (4) Proceed. Amer. Acad. New Series. 5. Ber. 11. 255, Jahresb. Ph. Tox. 1878. 259. Jahresb. 30. 284. Watts Dict. 1. 318. Ros. and Sch. 2. 2. 316. (5) J. pr. Chem. 18. 449. J. Ph. Chim. 25. 516. Gmelin. Watts Transl. 4. 366. Ros. and Sch. 2. 2. 316. (6) Annalen 94. 257. Pharm. Centr. 1855. 771. Jahresb. 8. 37. (7) Gilb. Ann. 49. 357. Gmelin. Watts Trans. 4. 366. (8) Watts Dict. 1. 318. (9) Proceed. Amer. Acad. New Series. 5. Ber. 11. 255. Jahresb. Ph. Tox. 1878. 259. Jahresb. 30. 284. (10) Chem. Soc. J. 33. 281. (11) Annalen. 94. 257. Pharm. Centr. 1855. 771. Jahresb. 8. 37. Ros. and Sch. 2. 2. 316. Miller 600. (12) J. pr. Chem. 18. 449. J. Ph. Chim. 25. 516. Gmelin. Watts Transl. 4. 336.

†(1) Ros. and Sch. 2. 2. 316. (2) Gmelin. Watts Transl. 4. 284. Watts Dict. 1. 371. Ros. and Sch. 1. 522. (3) Pogg. Ann. 131. 117. (4) Chem. Soc. J. 37. 352. (5) Ann. Chim. Phys. 33. 337. Pogg. Ann. 9. 315. Annalen 92. 277. Watts. Dict. 1. 371. Gmelin. Watts Transl. 4. 284. Miller 586. (6) Compt. rend. 27.213.

at 56°, Mulder (7), and becomes anhydrous at 100° (8), at 113° (9), or at 121°, Mulder (7). The an-hydrous salt melts at a full red heat (10) and when fused in the air it loses chlorine and becomes alkaline under the formation of baryta, E. Kraus (11). Dumas (1),* Marignac (2). When the salt is heated in a glass at the highest temperature that the glass can bear, it neither melts nor decomposes, Edward Kraus (3).

Bismuth Chloride. $BiCl_3$.

Bismuth chloride melts at 225–230°, M. P. Muir (4), forming an oily liquid, J. Davy (5), which boils at 427–439°, T. Carnelley and W. C. Williams (6), volatilizes at a moderate heat, H. Davy (5), and sublimes in the form of beautiful crystals, M. P. Muir (7). When the salt is distilled in vessels containing air it yields a small quantity of oxychloride of bismuth in the form of micaceous laminæ, Jacquelin (5).

Cadmium Chloride. $CdCl_2 2H_2O$.

Cadmium chloride with 2 mol. of water of crystallization melts when heated and yields the anhydrous salt, Stromeyer (1),† which fuses at 541°, T. Carnelley (2), boils above 861° T. Carnelley and W. C. Williams (3), and on cooling forms a transparent laminated pearly mass, and which at a more elevated temperature sublimes in the form of transparent micaceous plates, Stromeyer (1).

Calcium Chloride. $CaCl_2\ 6H_2O$.

Calcium chloride with 6 mol. of water melts at 28.5°, Person (4),

Pogg. Ann. 76. 458. Ros. and Sch. 1. 522. (7) Gmelin-Kraut. 2. 1. 300. (8) Watts Dict. 1. 502. (9) Ros. and Sch. 2. 1. 223. (10) Gmelin-Kraut 2. 1. 300. Watts Dict. 1. 502. Ros. and Sch. 2. 1. 223. (11) Pogg. Ann. 43. 140. Berzelius' Jahresb. 19. 234. Gmelin-Kraut. 2. 1. 300. Ros. and Sch. 2. 1. 223.

* (1) Gmelin-Kraut. 2. 1. 300. (2) Recherch. 13. Jahresb. 8. 342. Gmelin-Kraut. 2. 1. 300. (3) Pogg. Ann. 43. 140. (4) Chem. Soc. J. 29. 144. Chem. News. 32. 277. Jahresb. 29. 264. Ros. and Sch. 2. 2. 336. (5) Gmelin. Watts Transl. 4. 438. (6) Chem. Soc. J. 33. 281. Chem. News. 37. 212. Dingl. pol. J. 230. 440. Jahresb. 31. 36. (7) Chem. Soc. J. 29. 144. Jahresb. 29. 264. Ros. and Sch. 2. 2. 336.

† (1) Ann. Chim. Phys. 11. 81. Gmelin-Kraut. 3. 72. Watts Dict. 1. 703. Ros. and Sch. 2. 1. 267. (2) Chem Soc. J. 33. 273. (3) Chem. Soc. J. 33. 281. (4) Compt. rend. 23. 162. Ann. Chim. Phys. [3] 27. 250. Pogg. Ann. 70. 300. Annalen 64. 179. Instit. 1846. 247. Comp. rend. 29. 300. Jahresb. 1. 72. 2. 32

at 29°, Herman Kopp (5), at or near 34°, Mulder (6), loses 4 mol. at 200° Mitscherlich (7), at 150° if the heat be prolonged (8), or after 12 days in a vacuum in the heat of the sun (9), and becomes anhydrous at a more elevated temperature (10), or at 130° in dry air, losing at the same time a trace of its acid, H. C. Dibbits (1).* The anhydrous salt melts at 719°, T. Carnelley (2), or at 723°, T. Carnelley (3), and when subjected for 10 minutes to a white heat, one portion is converted into calcium oxide, another portion is left undecomposed in the residue, while still another portion is volatilized unchanged, Al. Mitscherlich (4). When the salt is ignited in the air, a small portion is converted into the oxide, Edward Kraus (5), Liebig (6) or into the oxide and carbonate of calcium (7).

Chromium Chloride Cr_2Cl_6.

Hydrated chloride of chromium loses water and acid at 170°, and at 200° there remains a green mass, which with water yields a dark green solution, in which is found a light blue, and a dark red, powder, the former of which has the composition of $Cr_2O_3+3Cr_2Cl_6$, the latter $Cr_2O_3+2Cr_2Cl_6$, Moberg (8). The anhydrous salt, when heated to redness in the air, yields the green chromium oxide, H. Rose (1) † Wöhler (2); but when heated in a sealed porcelain crucible in a reverberatory furnace at almost the melting point of the crucible, it on removal consists of green chromium chloride, and some peach-blossom colored needles, which are attached to the sides of the crucible, H. Gaultier de Claubry (3). When the hydrated chloride of chromium is heated in a closed vessel at 300°, or a little below an incipient redness, it is converted into the violet insoluble sesqui-chloride, Henry Loewell (4).

Gmelin-Kraut. 2. 1. 396. (5) Annalen 93. 206. Instit. 1855. 260. Phil. Mag. J. [4] 9. 477. Pharm. Centr. 1855. 219. Jahresb. 8. 44. Gmelin-Kraut. 2. 1. 396. Ros. and Sch. 2. 1. 192. Miller 415. (6) Gmelin-Kraut 2. 1. 396. (7) Gmelin-Kraut. 2. 1. 396. Ros. and Sch. 2. 1. 192. (8) Miller 415. (9) Annalen 29. 31. Gmelin-Kraut. 2. 1. 396. (10) Ros. and Sch. 2. 1. 192.

*(1) Arch. néerland 13. 478. Jahresb. 32. 132. (2) Chem. Soc. J. 33. 273. (3) Chem. Soc. J. 29. 489. Zeitschr. Anal. Chem. 17. 469. (4) J. pr. Chem. 83. 485. Zeitschr. Anal. Chem. 1. 63. Jahresb. 14. 843. Gmelin-Kraut, 2. 1. 393. (5) Pogg. Ann. 43. 139. Gmelin-Kraut. 2. 1. 393. (6) Gmelin-Kraut. 2. 1. 393. (7) Watts Dict. 1. 718. (8) Berzelius' Jahresb. 23. 229. Annalen 48. 229.

†(1) Read at Berlin Academy, Oct. 15, J. pr. Chem. 16. 214. Gmelin-Kraut. 2. 2. 315. Watts Dict. 1. 942. Ros. and Sch. 2. 2. 163. (2) Phil. Mag. J. [4] 18. 456. (3) Ann. Chim Phys. 45. 110. (4) Ann. Chim. Phys. [3]

Cobaltous Chloride, $CoCl_2 6H_2O$.

Crystallized cobaltous chloride with 6 mol. of water melts at 86.7° to a blue liquid, which begins to boil at 111°, and which at 116° loses 2 mol., and at 121° 4 mols., yielding a dark crystalline powder of the composition of $CoCl_2 2H_2O$, which at a temperature higher than 140° becomes anhydrous, Bersch (5). The anhydrous salt, when strongly heated, melts and sublimes, Proust (1), or sublimes without melting, Fellenberg (1).*

Cupric Chloride. $CuCl_2 2H_2O$.

Cupric chloride with 2 mol. of water melts at a gentle heat, Proust (2), becomes brown at 100° under evolution of most of its water, but loses the whole only at 200°, Graham (3), even at 101°, A. Vogel (4), or begins to give off water slowly at 90°, and when heated more strongly yields the oxide of copper, J. H. Gladstone (5). The anhydrous chloride melts at 498°, T. Carnelley (6), or at a red heat under the evolution of $\frac{1}{2}$ of its chlorine and forms thereby the cuprous salt, H. Rose (7). Even at an incipient redness the salt is decomposed, the reaction being represented by the following equation, $3CuCl_2 = Cu_2Cl_2 \cdot CuCl_2 + 2Cl$, A. Vogel (8). At 205° cupric chloride is converted into cuprous chloride and metallic copper, John Davy (9).

Cuprous Chloride Cu_2Cl_2.

Cuprous chloride melts at 434°, T. Carnelley (1),† or at a temperature a little below an incipient redness to a yellow liquid, which is not decomposed at a strong red heat in closed vessels, but which, if air be freely admitted, is dissipated in the form of white fumes, John Davy (2). The salt, when heated between 100° and 200° in a

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15. 48. (5) Wien. Akad. Ber. [2] 56. 724. J. pr. Chem. 103. 252. Zeitschr. Chem. 1868. 574. Chem. Centr. 1868. 332. Jahresb. 20. 29. Gmelin-Kraut. 3. 456. Ros. and Sch. 2. 2. 130.

* (1) Gmelin-Kraut 3. 455. (2) Gmelin-Kraut 3. 642. (3) Annalen 29. 31. Gmelin-Kraut 3. 642. Watts Dict. 2. 52. (4) Dingl. pol. J 136. 239. Jahresb 8. 413. Gmelin-Kraut 3. 642. (5) Chem. Soc. J. 8. 212. Jahresb. 8. 414. (6) Chem. Soc. J. 33. 273. (7) Gmelin-Kraut 3. 642. Watts Dict. 2. 52. Ros. and Sch. 2. 1. 334. Miller 621. (8) Gmelin-Kraut 3. 642. (9) Phil. Trans. 1812. 169. J. pr. Chem. 66. 376. Abstracts of Phil. Trans. of Roy. Soc. 1. 425.

† (1) Chem. Soc. J. 33. 273. (2) Phil Trans. 1812. 169. Abstracts to Phil.

stream of moist air, changes very quickly into an oxy-chloride, Millet (3).

Ferric Chloride $Fe_2Cl_6 6H_2O$.

Crystallized ferric chloride with 6 mol. of water melts at 31°, Ordway (4), or melts easily and congeals again at 42°, Fritzsche (5). The anhydrous salt is volatile, John Davy (6) at somewhat over 100° and sublimes, forming large hexagonal tablets, Deville and Troost (7).

Ferrous Chloride $FeCl_2$.

Ferrous chloride melts at a red heat and volatilizes above the melting point of glass, John Davy (1).* When the salt is heated with a moderate admission of air, ferric chloride sublimes and ferric oxide is left behind (2); but in the open air chlorine escapes and peroxide of iron remains (3).

Lead Chloride $PbCl_2$.

Lead chloride melts at 498° T. Carnelley, (4), at 524° T. Carnelley (5), or at 580°, Braun (6), and boils above 861°, T. Carnelley and W. C. Williams (7), forming on cooling a translucent white horny mass (8). Chloride of lead does not volatilize at a strong red heat if the air be excluded, J. Davy (9), or it may be sublimed though with difficulty (10); but when heated in the air it gives off vapors and leaves the oxychloride, Döbereiner (11).

Magnesium Chloride $MgCl_2 6H_2O$.

Crystallized magnesium chloride with 6 mol. of water begins to lose acid at 106°, is semi-liquid at 112° and entirely melted at 119°,

Trans. of Roy. Soc. 1. 425. Gmelin-Kraut 3. 640. Watts Dict. 2, 54. (3) Compt. rend. 66. 349. Jahresb. 19. 125. Gmelin-Kraut 3. 641. (4) Amer. J. Sci. [2] 40. 329. Zeitschr. Chem. 1868. 23. Jahresb. 18. 262. (5) J. pr. Chem. 18. 479. Gmelin-Kraut 3, 357. (6) Phil. Trans. 1812. 169. Abstracts to Phil. Trans. of Roy. Soc. 1. 425. Miller 520. (7) Compt. rend. 45. 821. Jahresb. 10. 224. Gmelin-Kraut 3. 356. Watts Dict. 3. 377. Ros. and Sch. 2. 2. 98.

*(1) Schw. 10. 326. Gmelin-Kraut 3. 355. Watts Dict. 3. 376. Ros. and Sch. 2. 2. 92. Miller 520. (2) Gmelin-Kraut 3, 354. Watts Dict. 3. 376. Ros. and Sch. 2. 2. 92. (3) Miller 520. (4) Chem. Soc. J. 33. 273. (5) Chem. Soc. J. 21. 381. Zeitschr. Anal. Chem. 19. 175. (6) Pogg. Ann. 154. 190. (7) Chem. Soc. J. 33, 281. 35, 563. Ber. 12. 1360. (8) Gmelin-Kraut 3. 246. Watts Dict. 3. 538. Ros. and Sch. 2. 1. 286. (9) Gmelin-Kraut 3. 246. (10) Watts Dict. 3. 538. (11) Schw. 17. 255. Gmelin-Kraut 3. 246. Watts Dict. 3. 538. Ros. and Sch. 2. 1. 286.

Brandes (1),* and changes under loss of water and hydrochloric acid into a mixture of magnesia and a little chloride of magnesium, H. Davy (2), or into pure magnesia (3). The crystallized salt loses 5 mol. of water when heated in dry air at 100°. A four hours heating at 100–130° causes a slight loss of acid, about 0.1 per cent., and only after 4 hours at 180° is the loss equivalent to 6 mol. of water; but even then the salt cannot be anhydrous, for some of the loss is due to the acid expelled, Dibbits (4). The anhydrous salt melts below a red heat (5), or at a red heat (6) or at 708°, T. Carnelley (7), and suffers a temperature at redness in dry air without decomposition, but with moisture present it decomposes into magnesia and hydrochloric acid, Gay-Lussac and Thenard (8) H. Kunheim (9). When magnesium chloride is heated by itself it changes into magnesia, containing however, an unweighable amount of chlorine, M. Kretschy (1).†

Manganic Chloride. Mn_2Cl_6.

Manganic Chloride, when heated, is converted into chlorine and manganous chloride, $Mn_2Cl_6 = 2MnCl_2 + Cl_2$ (2).

Manganous Chloride. $MnCl_2\ 4H_2O$.

Manganous chloride with 4 mol. of water becomes white and opaque at 25°, gives off hygroscopic water between 25° and 37°, at 37.5° becomes tough; at 50° semi-liquid; at 87.5° it fuses, forming a mobile liquid, which boils at 106°, John (3); and if kept near 100° for some time, it loses 28 per cent. of its water, retaining 1 mol., Brandes (3). At the last named temperature the salt appears to lose hydrochloric acid and to be partially transformed into the insoluble chloride, Krecke (4). The anhydrous chloride of manganese melts to an oily liquid at a dull red heat (5), but does not volatilize at a temperature under the melting point of glass, R. Fresenius (6), or on the other hand it does volatilize even at a red

*(1) Br. Arch. 12. 195. Gmelin-Kraut 2. 1. 468. (2) Gmelin-Kraut 2. 1. 468. (3) Ros. and Sch. 2. 1. 241. (4) Jahresb. Ph. Tox. 1877. 279. (5) Watts Dict. 3. 752. (6) Miller 452. (7) Chem. Soc. J. 33. 273. (8) Recherch. 3. 143. Gmelin-Kraut 2. 1. 467. (9) Jahresb. 14. 149. Gmelin Kraut 2. 1. 467.

†(1) Zeitschr. Ann. Chem. 15. 57. (2) Miller 549. (3) Gmelin-Kraut 2. 2. 495. Watts Dict. 3. 804. (4) J. pr. Chem. 113. 105. Gmelin-Kraut 2, 2, 496. (5) Gmelin-Kraut 2. 2 495. Watts Dict. 3. 804. Ros. and Sch. 2. 2. 6. (6) Zeitschr. Anal. Chem. 11. 424. Gmelin-Kraut 2. 2. 495. Watts Dict. 3. 804.

heat, Wright and Menke (1).* The salt is not decomposed at a red heat if air be excluded; but when ignited in an open crucible hydrochloric acid is evolved and oxide of manganese remains, John Davy (2), or manganoso-manganic oxide (3).

Mercuric Chloride. $HgCl_2$.

Mercuric chloride melts at 254° (4), at 265° (5), at 288°, T. Carnelley (6), or at 302°, T. Carnelley (7), boils at 295° (8), or at 303°, T. Carnelley and W. C. Williams (9), and volatilizes somewhat more easily than calomel (10). Mercuric chloride sublimes at or near 93.3° leaving no residue, W. A. Guy (11).

Mercurous Chloride. Hg_2Cl_2.

Mercurous chloride volatilizes at 138° without previously melting and leaving a residue, Wm. A. Guy (11), volatilizes below a red heat (12), does not decompose into metallic mercury and mercuric chloride at 440°, as shown by the fact that gold leaf does not lose its brightness or its ductility, when brought in contact with vapors of calomel, Debray (1),† but does decompose at that temperature, for a cold silver tube, when brought in contact with the vapors, is covered over with a film of mercury, Debray (2). When calomel is sublimed a small portion is always converted into metallic mercury and corrosive sublimate, Erlenmeyer (3), Deville and Troost (4). Gold leaf forms an amalgam in the vapor of calomel, Odling (5).

Nickelous Chloride. $NiCl_2$.

Nickelous chloride sublimes in a vacuum without decomposition; but when strongly heated in a retort the sublimation occurs under the evolution of some chlorine, and the formation of some nickelous oxide, Otto Linne Erdmann (6).

* (1) Chem. Soc. J. 37. 28. Gmelin-Kraut 2. 2. 495 (2) Phil. Trans. 1812. 169. Abstracts to Phil. Trans. of Roy. Soc. 1. 425. (3) Watts Dict. 3. 804. Ros. and Sch. 2. 2. 6. (4) Miller 656. (5) Watts Dict. 3. 897. (6) Chem. Soc. J. 33. 273. (7) Chem. Soc. J. 29. 489. Zeitschr. Anal. Chem. 17. 469. (8) Watts Dict. 3. 897. Miller 656. (9) Chem. Soc. J. 33. 281. (10) Gmelin-Kraut 3. 788. Watts Dict. 3. 897. Ros. and Sch. 2. 1. 404. (11) Pharm. J. Trans. 1868. 370. Amer. J. Pharm. 40. 246. Jahresb. Ph. Tox. 1868. 562. (12) Ros. and Sch. 2. 1. 399. Watts Dict. 3. 895.

† (1). Compt. rend. 66. 1339. Instit. 1868. 210. Zeitsch. Chem. 1868. 543. J. pr. chem. 107. 254. Amer. J. Sci. [2] 46, 398. Ber. 9. 1443. Jahresb. 21. 271. Gmelin-Kraut 3. 783. (2) Compt. rend 83. 330. Ber. 9. 1443. Jahresb. Ph. Tox. 1876, 308. Ros. and Sch. 2. 1. 400. (3). Annalen 131. 124. Jahresb. 17. 280. Gmelin-Kraut 3. 783. Ros. and Sch. 2. 1. 400. Miller 655. (4). Ros. and Sch. 2. 1. 400. (5). Jahresb. 17. 280. Gmelin-Kraut 3. 783. (6) J. pr. chem. 7. 251. Gmelin-Kraut 3. 553. Ros. and Sch. 2. 2. 150.

Potassium Chloride. KCl.

Potassium chloride decrepitates in the heat (1)* melts at 730°, Braum (2), at 734°, T. Carnelley (3), at 770° T. Carnelley (4), or at a low red heat (5), and volatilizes unchanged at strong redness (6), losing some in weight even by melting, Stas (7). 1. 0255 grams of the salt, when subjected to a red heat for 8 hours, lost 0.1735 gram, H. Rose (8). 2. 6225 grams was entirely volatilized after a 6 minute heating at dark redness, A. Mitscherlich (9). For comparison of the volatility of potassium chloride with that of sodium chloride, see Bunsen (10).

Silver Chloride. Ag Cl.

Silver chloride when heated assumes a yellow color (11), melts at 260° (12), at 350°, G. F. Rodwell (13) at 451°, T. Carnelley (3), or 457°, T. Carnelley (14), to a translucent orange yellow liquid (1),† and vaporizes undecomposed at a higher temperature (2). Silver chloride will endure a temperature of 150° without loss, if light, and organic matter be excluded; and if a portion of this dry chloride be heated in a test tube, it loses a part of its acid, sufficient to redden litmus, but the loss does not reach an appreciable quantity, Dr. Turner (3).

Sodium Chloride. Na Cl.

Sodium chloride decrepitates when heated, Karsten (4), T. Carnelley (5), melts at 772°, T. Carnelley (6), at 776°, T. Carnelley (5) at 960°, Braun (7), or at a red heat (8), crystallizing on coo ling (9) It volatilizes somewhat at its melting point, Stas (10), at a tempera-

* (1) Gmelin-Kraut 2. 1. 73. Watt's Dict. 4. 697. (2) Pogg. Ann. 154. 190. (4) Chem. Soc. J. 31. 381. Zeitschr. Anal. Chem. 19. 175. (3) Chem. Soc. J. 33. 273. (5) Watt's Dict. 4. 697. (6) Gmelin-Kraut 2. 1. 73. Watt's Dict. 4. 697. Ros and Sch. 2. 1. 68. (7) Gmelin-Kraut 2. 1. 73. (8) Pogg. Ann. 31. 133. (9) J. pr. Chem. 83. 485. Zeitsch. Anal. Chem. 1. 63. (10) Annalen 138. 264. Zeitsch. Anal. Chem. 5. 351. Phil. Mag. J. [4] 32. 81. Jahresb. 19. 766. (11) Gmelin-Kraut 3. 942. Ros. and Sch. 2. 1. 370. (12) Gmelin-Kraut 3. 942. Watt's Dict. 5. 296. Ros. and Sch. 2. 1. 370. Miller 684. (13) Proc. Roy. Soc. 25. 280. (14) Chem. Soc. J. 39. 489. Zeitschr Anal Chem. 17. 469.

† (1) Gmelin-Kraut 3. 942. Ros. and Sch. 2. 1. 370. (2) Gmelin-Kraut 3. 942. (3) Phil. Trans. 1833. pr. 2 p 534. Phil. Mag. J. [3] 4. 397. (4) Gmelin-Kraut 2. 1. 205. (5) Chem. Soc. J. 29. 489. Zeitschr. Anal. Chem 17. 469. (6) Chem. Soc. J. 33. 273. (7) Chem. Soc. J. 28. 31. (8) Gmelin-Kraut 2. 1. 205. Watt's Dict. 5. 336. (9) Watt's Dict. 5. 336. Ros. and Sch. 2. 1. 113. (10) Gmelin-

ture above its melting point, T. Carnelley (5), at a low red heat in an open vessel, H. Rose (11), or at a white heat even in closed vessels (11), but cannot be decomposed, Edward Kraus (12). A small quantity of the salt lost 62 per cent. of its weight when heated for 15 minutes at a strong red heat, A. Mitscherlich (13). 1.016 grams, when subjected to a red heat in a small platinum crucible, losses .07745 gram, H Rose (1).* For comparison of its volatility with that of other salts, see Bunsen (2).

Stannic Chloride $SnCl_4$.

Stannic chloride with 3 mol. of water melts at 80° and on cooling solidifies to a crystalline mass; at a stronger heat it evolves water and hydrochloric acid and leaves stannic oxide behind, Casselmann (3). The salt with 5 mol. of water melts at a low temperature, and on cooling again solidifies to a crystalline mass, Gerlach (4). The anhydrous salt does not solidify at −29,° Dumas (5), boils at 113.9°, Thorpe (6), at 112.5°, Andrews (7), at 115.4°, Pierre (8), at 120°, Dumas (9), or at 162°, Haagen (10).

Stannous Chloride. $SnCl_2$.

Stannous chloride crystallized with 2 mol. of water melts at 37.7–40.5° and crystallizes very easily on cooling, Penny (1); † but when more strongly heated it loses water and hydrochloric acid, which contains some metallic tin, and leaves stannous chloride and oxide behind (2). The salt with 3 mol. of water melts at 80°, solidifying again on cooling, and at a stronger heat loses water and hydrochloric acid, while stannic oxide remains behind, W. Cassel-

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Kraut 2. 1. 205. Ros. and Sch. 2. 1. 113. (11) Watt's Dict. 5. 336. (12) Pogg. Ann. 43. 140. (13) J. pr. Chem. 83. 485. Zeitschr Anal. Chem. 6. 217.

*(1) Pogg. Ann. 31.133. (2) Annalen 188. 264. Zeitschr. Anal. Chem. 5. 351 Phil. Mag. J. [4] 32. 81. Jahresb. 19. 766. (3) Annalen. 83. 257. J. pr. Chem. 58. 187. Ann. Chim. Phys. [3] 38. 104. Jahresb. 5. 292. Gmelin-Kraut. 3. 127. Ros. and Sch. 2. 2. 247. (4) Dingl. Pol. J. 178. 49. Zeitschr. Chem. 1865. 731. Bull. Soc. Chim. [2] 4, 483. Chem. News. 13. 53. Jahresb. 18. 731. (5) Ann. Chim. Phys. 33. 385. Gmelin-Kraut. 3. 128. Ros. and Sch. 2. 2. 247 (6) Chem. Soc. J. 37. 331. (7) Gmelin-Kraut. 3. 128. (8) Compt. rend. 27. 213. Pogg. Ann. 76. 458. Gmelin-Kraut. 3. 128. Miller 562. (9) Ann. Chim. Phys. 33. 385. Pogg. Ann. 9. 434. Gmelin-Kraut 3. 128. Ros. and Sch. 2. 2. 247. (10) Pogg. Ann. 131. 171.

†(1) Chem. Soc. J. 4. 239. Gmelin-Kraut. 3. 124. Jahresb. 4. 356. Ros. and Sch. 2. 2. 242. (2) Gmelin-Kraut. 3. 124. Watts Dict. 5. 806. Ros. and Sch. 2.

mann (3). The anhydrous chloride melts at 250° to an oily liquid, Marx (4). Capitaine (5), boils at 617–628°, T. Carnelley and W. C. Williams (6), at a heat near redness, J. Davy (7), or a little below, Capitaine (8), always undergoing some decomposition J. Davy (7), the results of which are the perchloride and the yellow earthy subchloride of tin, Capitaine (9). When stannous chloride is heated to bright redness it evolves stannic chlorides, then stannous chloride, and leaves a black glittering residue of metallic tin, A. Vogel (1).*

Strontium Chloride. $SrCl_2$.

Strontium chloride with 6 mol. of water melts when heated, loses its water, (2) and becomes anhydrous at 100° (3). The anhydrous salt melts at 825°, T. Carnelley (4), at 829°, T. Carnelley (5), or at 910°, Braun (6), to a semi-transparent glassy mass, Dumas (7). When the chloride of strontium is kept for ¼ hour at a temperature at which it begins to volatilize in the form of a white cloud, it yields a mass which dissolves to a strongly alkaline liquid ; if this residue be moistened with water and heated again, and this repeated several times, there is formed a brownish-gray strongly alkaline mass, which, on being dissolved, leaves the oxide, Edward Kraus (8). When the salt is melted in the air it becomes alkaline, and at a red heat in a moist atmosphere it evolves hydrochloric acid, Kunheim (9).

Zinc Chloride. $ZnCl_2$.

Zinc chloride melts at a temperature somewhat above 100°, H. Davy (1),† at 262° Braun (2), or below a dull red heat, J. Davy (3),

2. 242. (3) Annalen. 83. 274. J. pr. Chem. 58. 189. (4) Gmelin-Kraut 3. 124. Watt's Dict. 5. 806. (5) J. Ph. Chim. Sept. 1839. Phil. Mag. J. [3] 15. 414. (6) Chem. Soc. J. 35.563. Ber. 12. 1360. (7) Schw. 10. 321. Gmelin-Kraut, 3. 124. Watt's Dict. 5. 806. (8) J. Ph. Chim. Sept. 1839. Phil. Mag. J. [3] 15. 414. Ros. and Sch. 2. 2. 242. (9) J. Ph. Chim. Sept. 1839. Phil. Mag. J. [3] 15. 414. Gmelin-Kraut. 3. 125. Watt's Dict. 5.806.

*(1) Schw. 21. 66. Gmelin-Kraut. 3. 124. Watts Dict. 5. 806. (2) Watts Dict. 5. 436. Ros. and Sch. 2. 1. 215. Miller 405. (3) Gmelin-Kraut. 2. 1. 336. (4) Chem. Soc. J. 33. 273. (5) Chem: Soc. J. 29. 489. Zeitschr. Anal. Chem. 17. 469. (6) Pogg. Ann. 154. 190. (7) Ann. Chim. Phys. [3] 55. 191. Gmelin-Kraut. 2. 1. 336. Watts Dict. 5. 436. Ros. and Sch. 2. 1. 215. (8) Pogg. Ann. 43. 139. Bergelius' Jahresb. 19. 234. Gmelin-Kraut. 2. 1. 336. (9) Dissertat Gottingen. 1861. Jahresb. 14. 149. Gmelin-Kraut. 2. 1. 336.

† (1) Gmelin-Kraut. 3. 30. Watts Dict. 5. 1069. Ros. and Sch. 2. 1. 260. Miller 466. (2) Pogg. Ann. 154.190. (3) Gmelin-Kraut. 3. 30. Watts Dict. 5.

boils at 676–683°, T. Carnelley and W. C. Williams (4), and sublimes at a red heat forming white needle-shaped crystals (5).

THE IODIDES.

Aluminium Iodide. Al_2I_6.

Aluminium iodide melts at about 185° to a thin liquid, whose boiling point is higher than that of mercury, Rud. Weber (1);* melts at 125° and boils at 350°, H. Sainte Claire Deville and Troost (2), or at 360° (3). When heated in a closed tube it sublimes in the form of delicate snow-white laminæ; but in the open air it is rapidly decomposed with the separation of iodine and formation of aluminium oxide, Rud. Weber (4).

Ammonium Iodide. NH_4I.

Ammonium iodide, when heated, evolves a portion of its ammonia and then sublimes in violet vapors, Gay-Lussac (5). The salt volatilizes without melting or decrepitating, undergoing, however, a partial decomposition, Dr. C. Herzog (6).

Antimonious Iodide. SbI_3.

Antimonious iodide melts at 171.8 (corr.) and boils at 414–427° with slight decomposition, the vapors having an intense, dark red color. T. Carnelley and W. C. Williams (1).† The salt melts at 167° and boils at a temperature that is higher than the boiling point of mercury, J. P. Cooke (2). Antimonious iodide melts at 164.4°, forming a reddish-brown liquid, which boils at a higher temperature, evolving orange-colored vapors, which condense to transparent bright red plates. When the sublimation is conducted in the air, decomposition takes place, iodine being liberated and oxy-iodide formed, R. W. E. MacIvor (3). The iodide becomes blackish-red every time

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1069. (4) Chem. Soc. J. 33. 281. (5) Gmelin-Kraut. 3. 30. Watts Dict. 5. 1069. Ros. and Sch. 2. 1. 260.

*(1) Pogg. Ann. 103. 259. J. pr. Chem. 74. 165. Chem. Gaz. 16. 269. Phil. Mag. J. [4] 15. 117. Gmelin-Kraut. 2. 1. 641. Watts Dict. 1. 157. Ros. and Sch. 2. 1. 448. (2) Compt. rend. 49. 239. Pogg. Ann. 108. 644. (3) Ros. and Sch. 2. 1. 448. (4) Pogg. Ann. 103. 260. 101. 467. J. pr. Chem. 72. 191. 74. 165. Chem. Centr. 1857. 633. Chem. Gaz. 15. 395. Phil. Mag. J. [4] 15. 117. Amer. J. Pharm. 30. 54. Jahresb. 10. 155. Gmelin-Kraut. 2. 1. 641. (5) Gmelin. Watts Transl. 2. 468. (6) Arch. der Pharm. Oct. 1844. Chem. Gaz. 2. 498.

†(1) Chem. Soc. J. 30. 281. (2) Proc. Amer. Acad. New Series, 6. Ber. 11. 255. Jahresb. Ph. Tox. 1878. 259. (3) Chem. Soc. J. 29. 328. 27. 870. Chem.

it is heated, and at a higher temperature distills in the form of scarlet vapors, Brandes (4). The distillation takes place at a moderate heat, Serrullas (4), a little above its boiling point, Berthelot (4) or even at 100°, J. P. Cook, (5).

Arsenious Iodide. AsI_3.

Arsenious iodide melts at 146°, T. Carnelley (1),* and boils at 394–414°, T. Carnelley and W. C. Williams (2). When the salt is heated in a retort it becomes fluid and on cooling solidifies again, remaining for the most part undecomposed, a little, however, being converted into iodine and metallic arsenic, Plisson (3) ; but if the heat be suddenly raised to 138° more complete decomposition takes place, Thomson (4).

Barium Iodide. $BaI_2 7H_2O$.

Barium iodide crystallized with 7 mol. of water melts, when heated, swells up and decrepitates strongly, forming a white mass, which fuses on further application of heat, and on raising the temperature still higher evolves iodine, Henry Croft (5) ; but when heated out of contact with the air the anhydrous salt is left (6). Barium iodide with 2 mol. of water, when melted in the presence of air, gives off a large amount of iodine, Werther (7). The anhydrous salt is not decomposed by heat in a closed vessel, but in contact with the air it rapidly decomposes, giving off vapors of iodine and leaving baryta behind (1).† Barium iodide after being melted crystallizes on cooling, J. Dumas (2).

Bismuth Iodide. BiI_3.

Bismuth iodide, when heated in a closed vessel, may be partially volatilized without alteration (3) ; but when heated in the air, it gives off brown vapors and leaves behind a basic iodide, R. Schneider (4), or is entirely converted into the oxide (3). When the salt is

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News 29. 255. (4) Gmelin, Watts Transl. 4. 362. (5) Proceed. Amer. Acad. New Series, 5. Jahresb. 30. 284. Jahresb. Ph. Tox. 1878. 259.

*(1) Chem. Soc. J. 33. 270. (2) Chem. Soc. J. 33. 281. (3) Ann. Chim. Phys. 39. 265. Pogg. Ann. 14. 609. Gmelin, Watts Transl. 4. 281. (4) Gmelin, Watts Transl. 4. 281. (5) Chem. Gaz. 15. 126. Ber. 10. 1343. J. pr. Chem. 68. 402. Chem. Centr. 1856. 404. Jahresb. 9. 333. (6) Watts Dict. 1. 504. (7) J. pr. Chem. 91. 331. Jahresb. 17. 189. Gmelin-Kraut. 2. 1. 293.

†(1) Watts Dict. 1. 504. (2) Ann. Chim. Phys. [3] 55. 191. (3) Watts Dict. 1. 594. (4) Pogg. Ann. 99. 470. Annalen 101. 66. J. pr. Chem. 70. 119. Ann.

heated in an open glass tube, it does not melt, but decomposes partially under the separation of iodine and formation of orange-red oxy-iodide of bismuth, J. Nickels (5).

Cadmium Iodide. CdI_2.

Cadmium iodide melts at 402°, W. E. Kay (6), at 404°, T. Carnelley (7), and solidifies again in a crystalline form; but when exposed to a more elevated temperature it decomposes under the loss of iodine, Stromeyer (8).

Calcium Iodide. CaI_2.

Calcium Iodide melts at 631°, T. Carnelley (1),* or below a red heat (2), crystallizing on cooling, J. Dumas (3), and, when heated in contact with the air, is decomposed with the formation of lime, and separation of iodine, Gay-Lussac (4).

Cobaltous Iodide. $CoI_2 6H_2O$.

Cobaltous iodide with 6 mol. of water becomes anhydrous at 130°, Walter Noel Hartley (5). The salt with 2 mol. of water ($CoI_2 2H_2O$), when heated at 100°, gives off a portion of its iodine under the formation of cobaltous oxide, W. N. Hartley (6).

Cuprous Iodide. Cu_2I_2.

Cuprous iodide melts at 601°, T. Carnelley (1), or at a red heat, forming a brown mass, on cooling, whose powder is green, Soubeiran (7).

Ferrous Iodide. FeI_2.

Ferrous iodide, crystallized with 5 mol. of water, when heated at over 100 ° in the air, evolves water and iodine and leaves ferric oxide behind, J. D. Smith (8), or a residue that is attracted by the

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Chim. Phys. [3] 50. 488. Chem. Centr. 1857. 57. Chem. Gaz. 15. 109. Jahresb. 9. 392. (5) Compt. rend. 50. 872. Instit. 1860. 156. J. Ph. Chim. [3] 37. 436. Jahresb. 13. 176. (6) Annalen 207. 65. (7) Chem. Soc. J. 33. 273. (8) Ann. Chim. Phys. 11. 83. Watts Dict. 1. 705. Ros. and Sch. 2. 1. 268.

*(1) Chem. Soc. J. 33. 273. (2) Watts' Dict. 1. 718. (3) Ann. Chim. Phys. [3] 55. 191. (4) Gilb. Ann. 49. 237. Gmelin-Kraut 2. 1. 391. Watts Dict. 1. 718. (5) Chem. News. 29. 161. Ros. and Sch. 2. 2. 131. (6) Chem. News. 29. 161. Chem. Soc. J. 27. 501. Jahresb. 27. 273. (7) Gmelin-Kraut 3. 635. Watts Dict. 2. 66. Ros. and Sch. 2. 1. 333. (8) Phil. Mag. J. 7. 156. Gmelin-Kraut 3. 350.

magnet, Faville (1). The anhydrous salt melts at 177°, Carius and Wanklyn (2), or at a red heat, forming on cooling a gray laminar mass and volatilizing at a stronger heat (3); but when heated in the air, violet vapors of iodine are evolved and a magnetic residue left behind, Faville (4), or ferric oxide alone remains, Todd. Thomson (5).

Lead Iodide. PbI_2.

Lead iodide, when heated, becomes reddish yellow, then a bright red and finally assumes a brownish black color, O. Henry (6), Brandes (7), and melts at a higher temperature, Gay-Lussac (8), or at 383°, T. Carnelley (9), to a reddish-brown liquid, which on cooling solidifies to a yellow mass, Brandes (10). If the salt be melted in the air, iodine is evolved and oxy-iodide of lead formed, Brandes (11).

Magnesium Iodide. MgI_2.

Magnesium iodide, when moistened and heated, gives off hydriodic acid, and leaves pure magnesia (1).*

Manganous Iodide. MnI_2.

Manganous iodide may be fused without decomposition when the air is excluded; but on admission of the air it is resolved into vapor of iodine and manganous oxide, Lassaigne (2).

Mercuric Iodide. HgI_2.

Mercuric iodide turns yellow when gently heated, melts at a higher temperature (3), at 200°, G. F. Rodwell and H. M. Elder (4), at 238°, Oppenheim (5), or at 253–254°, H. Köhler (6), boils at

(1) Compt. Rend. 55. 615. J. pr. Chem. 89. 253. Jahresb. 15. 192. (2) Annalen 120. 69. Gmelin-Kraut 3. 350. Ros. and Sch. 2. 2. 93. (3) Watts Dict. 3. 390. (4) Compt. rend. 55. 615. J. pr. Chem. 89. 253. (5) Gmelin-Kraut 3. 350. (6) Gmelin-Kraut 3. 242. Watts Dict. 3. 547. Ros. and Sch. 2. 1. 287. (7) Annalen 10. 266. Gmelin-Kraut 3. 242. (8) Gmelin-Kraut 3. 242. (9) Chem. Soc. J. 33. 273. (10) Annalen 10. 266. Gmelin-Kraut 3. 242. Watts Dict. 3. 547. Ros. and Sch. 2. 1. 287. (11) Annalen 10. 266. Gmelin-Kraut 3. 242. Watts Dict. 3. 547.

* (1) Gmelin-Kraut 2. 1. 464. Watts Dict. 3. 754. Ros and Sch. 2. 1. 242. (2) Gmelin-Kraut 2. 2. 492. Watts Dict. 3. 808. Ros. and Sch. 2. 2. 8. (3) Watts Dict. 3 904. Ros. and Sch. 2. 1. 406. (4) Proc. Roy. Soc. 28. 284. Miller 660. (5) Clarke's Constants of Nature. Gmelin-Kraut 3. 772. (6) Ber. 12. 608. Chem. Soc. J. 36. 602. Chem. News. 40. 77. Amer.

339–359°, T. Carnelley and W. C. Williams (7), and sublimes in bright yellow rhombic prisms (8). When mercuric iodide is put into a retort and heated, it melts and then volatilizes as a colorless gas, which condenses to a brown fluid, Deville (9). For the change of color that the salt undergoes in passing from one modification to the other by the aid of heat, see M. A. Hays (1),* R. Warington (2), Mitscherlich (3), G. F. Rodwell and H. M. Elder (4), and H. F. Talbot (5). If goldleaf be brought in contact with the vapors of mercuric iodide, heated to a red heat, it will become white and brittle under the formation of an amalgam, Debray (6).

Mercurous Iodide. Hg_2I_2.

Mercurous iodide, when heated, yields a sublimate of metallic mercury, and mercuroso-mercuric iodide, Labouré (7), or simply mercuric iodide (8). If the salt be carefully heated, it sublimes unchanged; but if rapidly heated, it melts at 290° to a black liquid, which boils at 310°, mercury being given off, and an oxy-iodide sublimed, P. Yvon (9).

Nickelous Iodide. $Ni\ I_2.\ H_2O$.

Nickelous iodide with 6 mol. of water, when heated in contact with the air, gives off a little iodine, yields a sublimate of the anhydrous salt and leaves a residue of oxide of nickel (1).† The anhydrous salt, when heated out of contact with the air, sublimes without melting, only a trace of iodine vapor appearing; but if the sublimation be carried on in the open air much iodine is evolved and a residue of nickelous oxide with an unweighable trace of iodine is left behind, Erdmann (2).

J. Pharm. 51. 352. Jahresb. Ph. Tox. 1879. 123. (7) Chem. Soc. J. 33. 282. (8) Watts Dict. 3. 904. Ros. and Sch. 2. 1. 406. (9) Compt. rend. 62. 1157. Annalen 140. 170. J. pr. Chem. 99. [8]. Jahresb. 19. 41. Gmelin-Kraut 3. 773.

*(1) Schw. 59. 199. Amer. J. Sci. 16. 174. Phil. Mag. J. [3] 22. 210. (2) Phil. Mag. J. 21. 192. (3) Pogg. Ann. 28. 116. (4) Proc. Roy. Soc. 28. 284. Chem. Soc. J. 38. 443. (5) Phil. Mag. J. [3] 9. 1. (6) Compt. rend. 66. 1339. Instit. 1868. 210. Zeitschr. Chem. 1868. 543. J. pr. Chem. 107. 254. Amer. J. Sci. [2] 46. 398. (7) J. Ph. Chim. [3] 4. 329. Gmelin-Kraut 3 770. Watts Dict. 3. 904. (8) Watts Dict. 3. 904. Miller 660. (9) J. Ph. Chim. [4] 18. 167. Chem. Soc. J. 26. 1105. Chem. News 28. 44. Amer. Chem. 4. 356. Amer. J. Pharm. 45. 475. 525. Jahresb. Ph. Tox. 1873. 295. Ros. and Sch. 2. 1. 401.

†(1) Watts Dict. 4. 40. (2) J. pr Chem. 7. 256. Gmelin-Kraut 3. 551

Potassium Iodide. KI.

Potassium iodide melts at 634°, T. Carnelley (3), at 666°, Braun (4), or at 668°, T. Carnelley (5), solidifying again at 622°, T. Carnelley (6), to a pearly crystalline mass, Gay-Lussac (7), and when exposed to the air volatilizes undecomposed at a moderate heat (8). When the salt is dried at 180–200°, it undergoes no change; but if heated for ½ hour at 230–250°, it will be found to contain some iodic acid, Otto Petterson (9). For comparison of the volatility of potassium iodide with that of sodium chloride, see Bunsen (10).

Silver Iodide. AgI.

Silver iodide, when heated, remains unchanged in color up to about 105°; between 105° and 180° it assumes darker and darker shades of yellow; above 180° it becomes decidedly red, and darkens as the temperature is raised to 412°, at which point it is brick-red. At about 450° it fuses to a dark red liquid and begins to volatilize and decompose at a red heat. When cooled from 450° to 116° it contracts; but below 116° to —18° it expands, G. F. Rodwell (1).* Silver iodide fuses at 400° and on cooling expands between —10° and +70°, Fizeau (2).

When the fused salt is cooled to 138°, it exhibits a sudden alteration of color and transparency, Wernicke (3). Silver iodide melts at 527°, T. Carnelley (4), at 530°, T. Carnelley (5), or at a dull red heat (6), to a red liquid, which on cooling solidifies to a dingy yellow mass (7), of a horny texture, Berzelius (6), Stas (6), clear as

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(3) Chem. Soc. J. 33. 273. (4) Pogg. Ann. 154. 190. (5) Chem. Soc. J. 31. 381. Zeitschr. Anal. Chem. 19. 175. (6) Chem. Soc. J. 29. 499. (7) Gilb. Ann. 49. 26. Gmelin-Kraut 2. 1. 58. (8) Gmelin-Kraut 2. 1. 58. Watts Dict. 4. 704. (9) Zeitschr. Anal. Chem. 9. 362. Jahresb. Ph. Tox. 1870. 285. (10) Annalen 138. 264. Zeitschr. Anal. Chem. 5. 351. Phil. Mag. J. [4] 32. 81. Jahresb. 19. 766.

*(1) Proc. Roy. Soc. 23. 97. Chem. News 30. 289. See also Proc. Roy. Soc. 25. 280. Amer. Chem. 5. 430. Zeitschr. Anal. Chem. 14. 190. Ber. 7. 1794. (2) Compt. rend. 64. 314. 771. Pogg. Ann. 132. 292. Instit. 1867. 130. J. Ph. Chim. [4] 6. 435. Bull. Soc. Chim. [2] 8. 161. J. pr. Ch. 100. 507. Zeitschr. Chem. 1867. 171. Chem. News 15. 215. 16. 37. Phil. Mag. J. [4] 35. 456. Jahresb. 20. 44. Gmelin-Kraut 3. 930. Proc. Roy. Soc. 23. 97. Ros. and Sch. 2. 1. 374. (3) Pogg. Ann. 143. 560. Proc. Roy. Soc. 25. 280. (4) Chem. Soc. J. 33.273. (5) Chem. Soc. J. 29. 489. Zeitschr. Anal. Chem. 17. 469. (6) Gmelin-Kraut 3. 930. (7) Watts Dict. 5. 301.

glass, Schultz-Sellack (1). For an experiment with a paper coated with iodide of silver and held before the fire, see Talbot (2), and for the same experiment on porcelain, see Erdmann (3).

Sodium Iodide. NaI.

Anhydrous sodium iodide melts at 628°, T. Carnelley (4), or at 633°, T. Carnelley (5), forming on cooling a radiant pearly mass, Girault (6), and at a higher temperature volatilizing with a loss of part of its iodine (7). Sodium iodide, when melted in the air, loses some iodine under the formation of the oxide, Berzelius (6), and is less easily vaporized than potassium iodide, Gay-Lussac (6), Girault (6); but is more volatile than sodium chloride, Mohr (8); for comparison with the volatility of which, see Bunsen (9).

Stannic Iodide. SuI_4.

Stannic iodide melts at 146°, J. Personne (1),* solidifies again at 142°, J. Personne (2), sublimes at 180°, Thomas H. Henery (3), boils at 295°, J. Personne (4), or at 300° (5), and the vapors condense to yellowish-red needles very similiar in form to those of sal-ammoniac, J. Personne (6).

Stannous Iodide. SuI_2.

Stannous iodide melts at a dark red heat and distills at the temperature of melting glass, J. Personne (7); melts at 316°, and decomposes rapidly on boiling, T. Carnelley and W. C. Williams (8). The salt can be heated to redness if protected from the

(1) Gmelin-Kraut 3. 930. (2) Phil. Mag. J. [3] 12. 258. Pogg. Ann. 46. 326. J. pr. Chem. 4. 123. Gmelin-Kraut 3. 930. (3) J. pr. Chem. 14. 123. Gmelin-Kraut 3. 930. (4) Chem. Soc. J. 33. 273. (5) Chem. Soc. J. 29. 489. Zeitschr. Anal. Chem. 17. 469. (6) Gmelin-Kraut 2. 1. 195. (7) Watts Dict. 5. 338. (8) Annalen 21. 66. Gmelin-Kraut 2. 1. 195. (9) Annalen 138. 264. Zeitsch. Anal. Chem. 5. 351. Phil. Mag. [4] 32. 84. Jahresb. 19. 766.

* (1) Compt. rend. 54. 216. J. pr. Chem. 88. 76. Jahresb. 15. 171. Gmelin-Kraut 3. 122. Watts Dict. 5. 814. Ros. and Sch. 2. 2. 249. (2) Compt. rend. 54. 216. J. pr. Chem. 88. 76. Gmelin-Kraut 3. 122. Watts Dict. 5. 814. (3) Phil. Trans. 1845. 363. Abst. to Phil. Trans. of Roy. Soc. 5. 565. Chem. Gaz. 3. 397. Annalen 60. 215. Gmelin-Kraut 3. 122. Watts Dict. 5. 814. Ros. and Sch. 2. 2. 248. (4) Compt. rend. 54. 3. 216. J. pr. Chem. 88. 76. Jahresb. 15. 171. Gmelin-Kraut. 3. 122. Watts Dict. 5. 814. (5) Ros. and Sch. 2. 2. 249. (6) Compt. rend. 54. 216. J. pr. Chem. 88. 76. Jahresb. 15. 171. Gmelin-Kraut 3. 122. Ros. and Sch. 2. 2. 249. (7) Compt. rend. 54. 216. J. pr. Chem. 88. 76. Chem. Centr. 1862. 785. Zeitsch. Chem. Pharm. 1862, 174. Rep. Chim. pure. 4. 129. Jahresb. 15. 171. Gmelin-Kraut. 3. 121. Watts Dict. 5. 814. Ros. and Sch. 2. 2. 243. (8) Chem. Soc. J. 35. 563.

air without subliming, Thomas H. Henry (9); but when heated in the air it decomposes; stannic iodide subliming and stannous oxide remaining (1); * or yields besides stannic oxide, a substance which with water decomposes into stannic oxide and hydriodic acid, Boullay, (2), or into stannic oxide and stannic iodide, T. H. Henery (3).

Strontium Iodide. $Sr_2.6H_2O$.

Strontium iodide crystallizes with 6 mol. of water, melts when heated, swells up and decrepitates strongly, forming a white mass which fuses on further application of heat, and on raising the temperature still higher evolves iodine, Henry Croft (4). The anhydrous salt melts at 507°, T. Carnelley (5), solidifying to a glassy mass, Dumas (6), and undergoing no decomposition in a closed vessel; but when heated in contact with the air, it gives off iodine and is converted into strontia, Gay-Lussac (7).

Zinc Iodide. ZnI_2.

Zinc iodide melts at 446°, T. Carnelley (5), and decomposes when heated in the air into vapor of iodine and zinc oxide, Gay-Lussac (8).

THE NITRATES.

Aluminium Nitrate. $Al_2(NO_3)_6 18H_2O$.

Aluminium nitrate crystallized with 18 mol. of water, melts at 72.8°, boils at 134°, J. M. Ordway (1),† and decomposes at 150° (2); at 140° all the acid is expelled, H. Sainte-Claire Deville (3), and, at 200–250° aluminium oxide remains, Schlösing (4), but by partial decomposition a basic salt is formed, Ordway (5).

Ammonium Nitrate. NH_4NO_3.

Ammonium nitrate fuses imperfectly at 56° (6), perfectly at 108°

(9) Phil. Trans. 1845, 363. Annalen 60. 215. Chem. Gaz. 3. 397. Abst. to Phil. Trans. Roy Soc. 5. 565.

* (1) Watts Dict. 5. 814. (2) Ann. Chem. Phys. 34. 372. Gmelin-Kraut. 3. 121. (3) Phil. Trans. 1845, 363. Gmelin-Kraut 3. 121. (4) Chem. Gaz. 15. 126. J. pr. Chem. 68. 402. Ber. 10. 1343. Chem. Centr. 1856, 404. Jahresb. 9. 333. (5) Chem. Soc. J. 33. 273. (6) Ann. Chim. Phys. [3] 55, 191. Gmelin-Kraut. 2. 1. 332. (7) Gmelin-Kraut. 2.1. 332. Watts Dict. 5. 437. (8) Gmelin-Kraut. 3. 28. Watts Dict. 5. 1072.

† (1) Amer. J. Sci. [2] 27. 111. Ann. Chim. Phys. 76. 248. Chem. Gaz. 8. 61. Watts Dict. 4. 89. (2) Ros. and Sch. 2. 1. 457. (3) Ann. Chim. Phys. [3] 38. 9. Gmelin-Kraut 2. 1. 650. (4) Grandeau. Traite d'analyse. Paris. 1877, 105. (5) Amer. J. Pharm. [2] 26. 203. Gmelin-Kraut 2. 1. 650. (6) Gmelin. Watts

(7), at 145°, Frankenheim (8), at 152°, Berthelot (9), or at 165°–166°, S. Pickering (10), boils at 180° without decomposition (11), and begins to decompose at 185° into nitrous oxide and water, S. Pickering (10), at 210°, the gas increasing as the temperature is raised, Berthelot (9), at 238° (12), or at 230–250° (13), while at 250° the gas is evolved in abundance (12).

The decomposition does not take place below 190°–200°, Legrand (1),* and if the temperature be raised above 300° the reaction becomes explosive, Berthelot (2). If the salt be rapidly heated, ammonia, nitric oxide and nitrite of ammonium are formed, in addition to nitrous oxide, Berzelius (3). When the salt is placed upon a red-hot plate a yellow flame is produced, and a slight explosion occurs, accompanied by decomposition into nitrogen, water, and nitric oxide, a small portion of the salt subliming unchanged (4). For the construction of an apparatus for subliming the salt without decomposition, see Berthelot (5). For a tabulated statement of the reaction at different degrees, see (6). For the composition of the gas after it has been passed through water, and the theory of its formation, see P. A. Favre and J. I. Silbermann (7).

Barium Nitrate. $Ba(NO_3)_2$.

Barium Nitrate melts at 593°, T. Carnelley (8), and decomposes at a red heat, giving off oxygen, nitrogen, and peroxide of nitrogen (9), or nitrous anhydride, Riviere (10), and leaving a residue of pure baryta (1) † or of Ba_3O_4, Rammelsberg (2). Barium nitrate is entirely decomposed in a retort at a heat a little above that of simple

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Trans. 2. 490. (7) Gmelin. Watts Trans. 2. 490. Watts Dict. 1. 192. Miller 393. (8) Pogg. Ann. 93. 17. (9) Compt. rend. 82. 388. Ann. Chim. Phys. [5] 10. 362. J. Ph. Chem. [5] 24. 352. Chem. Soc. J. 32. 840. Jahresb. Ph. Tox. 1876, 288. Jahresb. 29. 193. (10) Chem. News. 38. 267. Chem. Soc. J. 36. 200. Jahresb. 31. 221. (11) Watts Dict. 1. 192. Amer. J. Pharm. 40. 409. (12) Gmelin. Watts Trans. 2. 490. Amer. J. Pharm. 40. 409. (13) Watts Dict. 1. 192.

* (1) Ann. Chim. Phys. 59. 435. (2) Ann. Chim. Phys. [5] 10. 362. J. ph. Chim. [5] 24. 352. Chem. Soc. J. 32. 840. (3) Watts Dict. 1. 192. (4) Ros. and Sch. 2. 1. 180. (5) Compt. rend. 82. 388. Chem. News 33. 210. Ber. 9. 730. (6) Amer. J. Pharm. 40. 409. (7) Ann. Chim. Phys. [3] 36. 19. (8) Chem. Soc. J. 33. 275. Ros. and Sch. 2. 1. 226. (9) Gmelin-Kraut 2. 1. 307. Watts Dict. 4. 89. (10) Mulhous. Soc. Bull. 36. 438. Gmelin-Kraut 2. 1. 307.

† (1) Gmelin-Kraut 2. 1. 307. Watts Dict. 4. 89. Miller 403. (2) Pogg. Ann. 137. 315. J. pr. Chem. 107. 353. Bull. Soc. Chim. [2] 12. 349. Zeitschr. Chem.

redness, H. Diville and H. Debray (3). Barium nitrite can be formed from the nitrate by a gentle and not too continuous red heat, Hess (4), by ignition, N. W. Fischer (5), or by keeping the salt at its melting point, Hampe (6).

Bismuth Nitrate $Bi(NO_3)_3$. $10H_2O$.

Bismuth nitrate when gently heated melts in its water of crystallization (7); at 78° it becomes a basic salt ($Bi_2O_3N_2O_5H_2O$), Graham (8), Ruge (9), the same being formed at 150°, Gladstone (10), which at 160° degrees sustains scarcely any further loss, Graham (11), or, on the other hand, it does give up its acid and water at that temperature, Gladstone (12).

Cadmium Nitrate $Cd(NO_3)_2$. $4H_2O$.

Cadmium nitrate melts at 59.5°, Ordway (1),* or at 100°, Carl von Hauer (2), and boils at 132°, remaining clear and mobile on prolonged boiling until $\frac{3}{4}$ of the water has been expelled, Ordway (3).

Calcium Nitrate. $Ca(NO_3)_2.4H_2O$.

Calcium nitrate crystallized with 4 mol. of water melts at 44°, Ordway (3), forming a mobile liquid, Million (4), which boils at 132°, remaining clear until about $\frac{1}{3}$ of the water has been driven off, and then depositing the anhydrous salt, Ordway (3). Anhydrous calcium nitrate melts at 561°, T. Carnelley (5), remaining undecomposed at an incipient fusion, but at a higher temperature decomposing with the evolution of oxygen and peroxide of nitrogen (6). Some nitrite of calcium is formed by ignition, N. W. Fischer (7), a little being formed even before the entire mass is

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1869. 373. Jahresb. 22. 223. Gmelin-Kraut 2. 1. 307. 258. (3) Ann. Chim. Phys. [3] 61. 118. (4) Pogg. Ann. 12. 270. Gmelin-Kraut 2. 1. 306. (5) Pogg. Ann. 74. 116. Chem. Gaz. 6. 281. (6) Annalen 125. 337. Jahresb. 16. 160. (7) Watts Dict. 4. 90. (8) Annalen 29. 16. Gmelin, Watts Transl. 4. 443. (9) Jahresb. 15. 163. (10) Mem. and Proc. Chem. Soc. 3. 480. J. pr. Chem. 44. 179. Jahresb. 1. 432. Watts Dict. 4. 90. (11) Gmelin, Watts Transl. 4. 443. (12) Mem. and Proc. Chem. Soc. 3. 480. J. pr. Chem. 44. 179. Jahresb. 1. 432. Gmelin, Watts Transl. 4. 443.

* (1) Amer. J. Sci. [2] 27. 14. Gmelin-Kraut 3. 73. Watts Dict. 4. 90. (2) Wien. Akad. Ber. 15. 23. J. pr. Chem. 64. 477. Chem. Soc. J. 8. 251. Chem. Gaz. 13. 221. Jahresb. 8. 391. Gmelin-Kraut 3. 73. (3) Amer. J. Sci. [2] 27. 14. Jahresb. 12. 115. Gmelin-Kraut 3. 73. Watts Dict. 4. 90. (4) Compt. rend. 4. 905. Gmelin-Kraut 2. 1. 410. (5) Chem. Soc. J. 33. 275. (6) Gmelin-Kraut 2. 1. 410 Watts Dict. 4. 90. (7) Pogg. Ann. 74. 115. An-

melted, J. Lang (1).* When the salt is heated just to the beginning of decomposition a phosphorescent residue remains (2).

Chromium Nitrate. $Cr_2(NO_3)_6 18H_2O$.

Chromium nitrate melts at 37° to a green liquid, which boils at 125.5°, Ordway (3). When the salt is heated on the water-bath until 39 per cent. of its weight is lost, the residue consists of $Cr_2O_3 \cdot 2N_2O_5 \cdot 12H_2O$; on continuing the heat, the residue, when dissolved in water, consists of chromate and nitrate of chromium, Ordway (4); the formation of chromic acid increases as the temperature is raised to redness, at which point nitric acid and oxygen are evolved and the green oxide left behind, Elliot and Storer (5).

Complete decomposition takes place at a red heat, with the formation of the oxide, Maus (6), Ordway (7).

Cobaltous Nitrate. $Co(NO_3)_2 \cdot 6H_2O$.

Cobaltous nitrate melts below 100°; when heated more strongly the violet liquid becomes thick and green, and then begins to boil, giving off nitrous fumes and leaving the black cobaltoso-cobaltic oxide behind (1). †

Cupric Nitrate. $Cu(NO_3)_2 \cdot 3H_2O$.

Cupric nitrate crystallized with 3 mol. of water melts at 114.5° and boils at 170°, giving off nitric acid and leaving a green basic salt, Ordway (2); at 65° it begins to lose nitric acid, a basic salt having the composition $Cu(NO_3)_2 + 3Cu(OH)_2$ being formed, Gra-

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nalen 68. 224. J. pr. Chem. 46. 318. Pharm. Centr. 1848. 401. Jahresb. 1. 383. Chem. Gaz. 6. 281.

*(1) Pogg. Ann. 118. 282. J. pr. Chem. 86. 295 J. Ph. Chim. [3] 42. 341. Rep. Ch. pure. 5. 77. Jahresb. 15. 101. Gmelin-Kraut 2. 1. 409. (2) Gmelin-Kraut 2. 1. 409. (3) Amer. J. Sci. [2] 27. 14. 9. 30. Annalen 76. 248. Jahresb. 12. 114. Gmelin-Kraut 2. 2. 326. Watts Dict. 4. 91. (4) Amer. J. Sci. [2] 26. 197. Jahresb. 11. 113. Gmelin-Kraut 2. 2. 326. Watts Dict. 4. 91. (5) Proc. Amer. Acad. 5. 192. Arch. Pharm. [2] 110. 221. Rep. Ch. appli. 3. 390. Jahresb. 14. 251. Gmelin-Kraut 2. 2. 291. (6) Pogg. Ann. 9. 127 Gmelin-Kraut 2. 2. 291. (7) Amer. J. Sci. [2] 9. 30. Chem. Gaz. 8. 61. Gmelin-Kraut 2. 2. 326.

†(1) Gmelin-Kraut 3. 458. Watts Dict. 4. 91. Ros. and Sch. 2. 1. 131. (2) Amer. J. Sci. [2] 27. 15. Jahresb. 12. 114. Gmelin-Kraut 3. 651. Watts Dict.

ham (3), Gerhardt (4), which is not decomposed at the temperature of melting lead; but at a stronger heat it evolves nitric acid, peroxide of nitrogen, oxygen, and water, and leaves cupric oxide (5). The salt with 6 mol. of water melts at 38°, is then, under loss of water and acid, transformed into a basic salt, and finally leaves 27 per cent. of the oxide, Proust (6).

Ferric Nitrate. $Fe_2(NO_3)_6.18H_2O$.

Ferric nitrate with 18 mol. of water melts at 47.2° to a clear deep-red liquid, which remains fluid until cooled to 28.3°, and which boils at 125°, decomposing partially at 100°, entirely at a red heat, Ordway (1),* even losing some of its acid at 50°, Scheurer-Kestner (2), ferric oxide being formed, H. Sainte-Clare Deville (3).

The nitrate with 12 mol. of water ($Fe_2(NO_3)_6.12H_2O$) melts at 35°, S. Hausmann (4), between 35° and 40°, Ordway (5), or under 50°, Schönbein (6).

Lead Nitrate. $Pb(NO_3)_2$.

Lead nitrate decrepitates when heated, detonates when thrown upon red-hot charcoal (7), and decomposes at an incipient red heat, yielding a mixture of oxygen and nitric peroxide, and leaving the yellow protoxide of lead. $Pb(NO_3)_2 = PbO + O + 2NO_2$ (8). For the formation of nitrite of lead by the action of heat upon the nitrate, see Bley (9).

Magnesium Nitrate. $Mg(NO_3)_2.6H_2O$.

Crystallized magnesium nitrate melts at 90°, begins to boil at 143°, and remains on further boiling a clear liquid, until 5 mol. of

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4. 92. (3) Phil. Trans. 1837. 57. Watts Dict. 4. 92. Ros. and Sch. 2. 1. 340. (4) Watts Dict. 4. 92. (5) Gmelin-Kraut 3. 650. Watts Dict. 4. 92. Ros. and Sch. 2. 1. 340. (6) Gmelin-Kraut 3. 651. Miller 623.

*(1) Amer. J. Sci. [2] 27. 14. Jahresb. 3. 327. 12. 114. Chem. Gaz. 8. 61. Gmelin-Kraut 3. 369. Watts Dict. 4. 93. (2) Gmelin-Kraut 3. 369. (3) Ann. Chim. Phys. (3) 38. 8. (4) Annalen 89. 109. J. pr. Chem. 61. 185. Pharm. Centr. 1854. 298. Chem. Gaz. 12. 211. Amer. J. Pharm. 26. 316. Jahresb. 6. 371. Gmelin-Kraut 3. 369. (5) Gmelin-Kraut 3. 369. (6) Pogg. Ann. 39. 141. Gmelin-Kraut 3. 369. (7) Gmelin-Kraut 3. 261. Ros and Sch. 2. 1. 289. Miller 640. (8) Gmelin-Kraut 3. 261. Watts Dict. 4. 94. Miller 640. (9) J. pr. Chem. 39. 23. Gmelin-Kraut 3. 255.

water and some acid have been expelled, Ordway (1).* By melting, the salt loses 34.14 per cent. of its water; the fused residue is not entirely deprived of its water at 400°, but loses the whole at a dark-red heat, together with a portion of its acid, which is volatilized as peroxide of nitrogen and oxygen, Graham (2). The nitrate of magnesium loses 5 mol. of water at 210°, and at 250°-255° the 6 mol., together with some nitric acid, Chodnew (3).

Manganous Nitrate. $Mn(NO_3)_2 \cdot 6H_2O$.

Manganous nitrate with 6 mol. of water, when heated, melts easily, John (4), even below 50-60°, Lührs (4), or at 25.8°, and boils at 129.5°, and if the boiling be continued there soon separates out the peroxide of manganese, Ordway (5).

Di-oxide of manganese is formed when the nitrate is heated at 150-195°, Schlösing (1),† or at 200, Kuhlmann (2.)

Mercuric Nitrate. $Hg(NO_3)_2 8H_2O$.

Mercuric nitrate melts at 6.6, forming a solution from which crystals of the composition $HgO \cdot Hg(NO_3)_2 3H_2O$ are deposited, Dritten (3). By heating either of the above salts until a pulverulent mass is obtained, pulverizing and treating 7 or 8 times with water, then the tri-mercuric salt is obtained, $Hg_3(NO_4)_2 \cdot H_2O$, which gives off its water at about 120°, and nitrous fumes at 250°, Million (4).

Mercurous Nitrate. $Hg_2(NO_3)_2$.

Mercurous nitrate melts at 100°, and if the heat be maintained it liberates water and nitric acid, nitrous vapors and deutoxide of nitrogen, leaving a yellow crystalline salt, which is the sub-nitrate of the proto-peroxide of mercury, C. Gerhardt (5). Mercurous nitrate, when heated, decomposes into hyponitric acid and mercuric oxide, $Hg_2(NO_3)_2 = 2HgO + N_2O_4$ (6).

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* (1) Amer. J. Sci. [2] 27. 14. Jahresb. 12 113. (2) Schw. 55. 195. Gmelin-Kraut 2. 1. 474. Watts Dict. 4. 95. (3) Annalen 71. 241. J. pr. Chem. 49. 107. Pharm. Centr. 1849. 857. Jahresb. 2. 262. Gmelin-Kraut 2. 1. 474. Watts Dict. 4. 95. (4) Gmelin-Kraut 2. 2. 501. (5) Amer. J. Sci. [2] 27. 14 Jahresb. 12. 114. Gmelin-Kraut 2. 2. 501. Ros. and Sch. 2. 2. 9.

† (1) Compt. rend. 55. 284. Instit. 1862. 261. Rep. Chim. pure. 4. 378. Zeitschr. Chem. Pharm. 1862. 571. Chem. Centr. 1863. 7. Dingl. Polyt. J. 166. 197. Jahresb. 15, 659. Gmelin-Kraut 2. 2. 446. (2) Dingl. Polyt. J. 211. 25. Jahresb. 27. 271. Gmelin-Kraut 2. 2. 446. (3) Jahresb. 7, 366. Gmelin-Kraut 3. 812. Watts Dict. 4. 96. (4) Am. Chim. Phys. [3] 18. 361. Gmelin-Kraut 3. 810. Watts Dict. 4. 96. (5) Compt. rend. 1848. 432. Chem. Gaz. 6. 249. (6) Gmelin-Kraut 3. 809.

Nickelous Nitrate. $Ni(NO_3)_2 \cdot 6H_2O$.

Nickelous nitrate with 6 mol. of water melts at 56.7°, and boils at 136.7° ; on continuation of boiling the liquid remains clear until 3 mol. of water are driven off, and then becomes thick under loss of acid, Ordway, (1).*

When nickelous nitrate is heated it leaves a yellow-green pulverulent basic salt, then peroxide and finally protoxide of nickel (2).

Potassium Nitrate. KNO_3.

Potassium nitrate melts at 313° (3), at 339°, C., Person (4), Quincke (5), T. Carnelley (6), at 342°, Braun (7), or at 368°, T. Carnelley (8), resolidifying at 338°, Schaffgotsch (9), or at 332°, T. Carnelley (10). When potassium nitrate is heated under pressure, it will stand redness without decomposition, Karsten (11); otherwise it decomposes, forming at first potassium nitrite, mixed with free alkali and undecomposed nitrate, N. W. Fischer (1)†, some nitrate remaining even after long heating, J. Lang (2), and finally a mixture of protoxide and peroxide of potassium (3).

Silver Nitrate. $AgNO_3$.

Silver nitrate melts 198°, Pohl (4), at 219° (5), at 217–218,° T. Carnelley (6), or at 233°, T. Carnelley, (7), resolidifying at 212°, Carnelley (8), and decomposes at an incipient red-heat into oxygen, peroxide of nitrogen, nitrogen and metallic silver (9). When the

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* (1) Amer. J. Sci. [2] 27. 14. Jahresb. 12. 114. Gmelin-Kraut 3. 556. (2) Watts Dict. 4. 97. (3) Watts Dict. 4. 99. (4) Ann. Chim. Phys. 21. 295. Pogg. Ann. 74. 522. 70. 301. Compt. rend. 23, 162. Annalen 64, 179. Jahresb. 1. 73. Gmelin-Kraut 2. 1. 91. Ros. and Sch. 2. 1. 80. Miller 340. (5) Pogg. Ann. 135. 642. Jahresb. 21. 20. Gmelin-Kraut 2. 1. 91. (6) Chem. Soc. J. 33. 273. (7) Pogg. Ann. 154. 190. (8) Chem. Soc. J. 31. 381. Zeitschr. Anal. Chem. 19. 175. (9) Pogg. Ann. 102. 293. Jahresb. 10. 18. Gmelin Kraut 2. 1. 91. (10) Chem. Soc. J. 29, 499. (11) Ph. Ch. Ber. 1843. 277. Gmelin-Kraut 2. 1. 92.

† (1) Pogg. Ann. 74. 115. Annalen 68. 224. J. pr. Chem. 46. 318. Pharm. Centr. 1848. 401. Chem. Gaz. 6. 281. Jahresb. 1. 383. (2) Pogg. Ann. 118. 282. J. pr. Chem. 86. 295. J. Ph. Chim. [3] 42. 341. Rep. Chim. pure. 5. 77. Jahresb. 15. 99. Gmelin-Kraut 2. 1. 92. (3) Gmelin-Kraut 2. 1. 91. Watts Dict. 4. 99. Miller 340. (4) Wien. Akad. Ber. 6. 587. Gmelin-Kraut 3. 953. Jahresb. 4. 59. Ros. and Sch. 2. 1. 377. (5) Watts Dict. 4. 104. Miller 686. (6) Chem. Soc. J. 33. 218. (7) Chem. Soc. J. 31. 381. Zeitschr. Anal. Chem. 19. 175. (8) Chem. Soc. J. 33. 273. (9) Gmelin-Kraut 3. 954.

salt is heated in a small retort until gas bubbles are evolved and red vapors begin to appear, oxygen gas is given off, and the residue consists of the nitrite, undecomposed nitrate, and a little metallic silver, J. Persoz (10).

Sodium Nitrate. $NaNO_3$.

Sodium nitrate melts at 310.5°, C. Person (1),* at 314°, Braun (2). at 316°, T. Carnelley (3), or at 330°, T. Carnelley (4), solidifying again at 313°, Schaffgotsch (5). Sodium nitrate, when subjected to a red heat, evolves at first oxygen under the formation of the nitrite, Mitscherlich (6), then a mixture of oxygen, nitrogen and some peroxide of nitrogen (7), or protoxide of nitrogen, H. Deville and H. Debray (8), and finally forms a mixture of protoxide and peroxide of sodium (9). The nitrite that is formed by subjecting the nitrate of sodium to a red heat is always contaminated with some undecomposed nitrate and some free alkali, N. W. Fischer (10), J. Lang (11).

Strontium Nitrate. $Sr(NO_3)_2$.

Strontium nitrate crystallized with 4 mol. of water ($Sr(NO_3)_2$. $4H_2O$) melts when heated under the separation of the anhydrous salt, Ordway (1),† losing its water at 100°, A. Souchay and E. Lensen (2), Brooke (3).

The anhydrous salt decrepitates when heated (4), melts at 645°, T. Carnelley (5), decomposes and leaves a residue of strontia (6),

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Ros. and Sch. 2. 1. 377. (10) Ann. Chin. Phys. [3] 23. 48. Chem. Soc. J. 1. 189. Annalen 65. 177.

* (1) Ann. Chim. Phys. 21. 295. Pogg. Ann. 70. 300. 74. 522. Annalen 64. 179. Jahresb. 1. 73. Gmelin-Kraut 2. 1. 218. Watts Dict. 4. 106. Ros. and Sch. 2. 1. 80. Miller 361. (2) Pogg. Ann. 154. 190. (3) Chem. Soc. J. 33. 273. (4) Chem. Soc. J. 29. 489 Zeitschr. Anal. Chem. 17. 469. Ros. and Sch. 2. 1. 80. (5) Pogg. Ann. 102. 293. Jahresb. 10. 18. Gmelin-Kraut 2. 1. 218. (6) Gmelin-Kraut. 1. 2. 459. 2. 1. 218. (7) Gmelin-Kraut 2. 1. 218. (8) Ann. Chim. Phys. [3] 61. 117. (9) Watts Dict. 4. 106. (10) Pogg. Ann. 74, 115. Annalen 68. 224. J. pr. Chem. 46. 318. Pharm. Centr. 1848. 401. Chem. Gaz. 6. 281. Jahresb. 1. 383. (11) Pogg. Ann. 74. 118. 281. J. pr. Chem. 86. 295. J. Ph. Chim. [3] 42. 341. Rep Chim. pure. 5. 77. Jahresb. 15. 100.

† (1) Amer. J. Sci. [2] 27. 14. Jahresb. 12. 113. Gmelin-Kraut 2. 1. 339. (2) Annalen 29. 45. J. pr. Chem. 69. 384. Gmelin-Kraut 2. 1. 339. (3) Gmelin-Kraut 2. 1. 339. (4) Gmelin-Kraut 2. 1. 339. Watts Dict. 4. 106. Ros. and Sch. 2. 1. 216. Miller 406. (5) Chem. Soc. J. 33. 273. (6) Gmelin-Kraut 2. 1.

under the evolution of oxygen and nitrogen (7). The nitrite is formed by the ignition of the nitrate, but is always contaminated with some free strontia, N. W. Fischer (8), and some undecomposed nitrate, J. Lang (9). The nitrite is formed by keeping the nitrate at its melting point, Hampe (10).

Zinc Nitrate. $Zn(NO_3)_2 \cdot 6H_2O$.

Zinc nitrate crystallized with 6 mol. of water melts at 36.4°, boils at 131°, and on long boiling remains clear until 42 per cent. of its weight has been lost; the residue on cooling consisting of $4ZnO \cdot 3N_2O_5 \cdot 3H_2O$, Ordway (1).*

When the salt is heated for some time at 100° it loses nitric acid and water and a basic salt remains, $9ZnO \cdot 2N_2O_5$, A. Vogel and C. Reischauer (2); there is also evolved peroxide of nitrogen and oxygen, Schindler (3); and at 105° in a stream of air it loses nearly all its water, Pierre (4). After the salt is boiled and cooled the residue consists of $ZnO \cdot 3Zn(NO_3)_2 \cdot 3H_2O$, Gerhardt (5), and if the heat be continued until the salt becomes nearly solid, the residue contains $8ZnO \cdot N_2O_5 \cdot 2H_2O$, Grouvelle (6).

THE NITRITES.

Ammonium Nitrite. NH_4NO_2.

Ammonium nitrite detonates when heated between 60 and 70°, Berthelot (1),† and is decomposed by a gentle heat, N. W. Fischer (2), into nitrogen and water, $NH_4NO_2 = N_2 + 2H_2O$ (3), or into water, nitrous oxide and ammonia (4).

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339. Watts Dict. 4. 106. (7) Miller 406. (8) Pogg. Ann. 74. 115. Annalen 68. 224. J. pr. Chem. 46. 318. Pharm. Centr. 1848. 401. Chem. Gaz. 6. 281. Jahresb. 1. 383. Gmelin-Kraut 2. 1. 339. (9) Pogg. Ann. 118. 282. J. pr. Chem. 86. 295. J. Ph. Chim. [3] 42. 341. Rep. Chim. pure. 5. 77. Jahresb. 15. 100. Gmelin-Kraut 2. 1. 339. (10) Annalen 135. 337. Jahresb. 16. 160. Gmelin-Kraut 2. 1. 339.

*(1) Amer. J. Sci. [2] 27. 14. Jahresb. 12. 113. Gmelin-Kraut 3. 34. (2) N. Jahrb. Pharm. 11. 137. Jahresb. 12. 196. Gmelin-Kraut 3. 34. Ros. and Sch. 2. 1. 262. (3) Gmelin-Kraut 3. 34. (4) Ann. Chim. Phys. [3] 16. 247. Gmelin-Kraut 3. 35. Watts Dict. 4. 107. (5) J. Ph. Chim. [3] 12. 61. Jahresb. 1. 436. Watts Dict. 4. 107. (6) Ann. Chim. Phys. 19. 137. Gmelin-Kraut 3. 34.

† (1) J. Ph. Chim. [4] 19. 428. Bull. Soc. Chim. [2] 21. 55. Chem. Soc. J. 27. 961. 1058. Chem. Centr. 1874. 245. Jahresb. Ph. Tox. 1877. 270. (2) Pogg. Ann. 74. 119. Annalen 68. 224. J. pr. Chem. 46. 318. Pharm. Centr. 1848. 401. Jahresb. 1. 383. (3) Watts Dict. 1. 192. Ros. and Sch. 2. 1. 180. (4)

Cadmium Nitrite. $Cd(NO_2)_2 \cdot H_2O$.

Cadmium nitrite is decomposed even by a gentle heat, N. W. Fischer (2), or is decomposed at 100°, forming thereby a basic salt, J. Lang (5).

Cobaltous Nitrite. $CoNO_2$.

Cobaltous nitrite is decomposed even by a gentle heat, N. W. Fischer (2).

Cupic Nitrite. $Cu(NO_2)_2$.

Cupric nitrite is decomposed even by a gentle heat, N. W. Fischer, (6). A solution of the salt evolves nitric oxide even at an ordinary temperature , W. Hampe (7).

Lead Nitrite. $Pb(NO_2)_2H_2O$.

Lead nitrite is easily decomposed, N. W. Fischer (1),* Peligot (2), and when heated at 100° evolves nitric oxide and leaves a basic salt behind, J. Lang (3).

Magnesium Nitrite. $Mg(NO_2)_2 \cdot 2H_2O$.

Magnesium nitrite is easily decomposed by heat, N. W. Fischer (1), evolving nitric oxide even at 100°, S. Lang (4), and after being heated to redness leaves 26.14 per cent. of magnesium oxide, W. Hampe (5).

Mercurous Nitrite. $Hg_2(NO_2)_2$.

Mercurous nitrite, when exposed to the action of heat, resists a temperature of 280,° but a 290° it begins to give off red vapors, J. Lefort (6).

Gmelin. Watts Transl. 2. 490. (5) Pogg. Ann. 98. 291. J. pr. Chem. 86. 295. J. P. Chim. [3] 42. 341. Rep. Chim. pure. 5. 77. Jahresb. 15. 100. Gmelin-Kraut 3. 73. Watts Dict. 4. 72. (6) Pogg. Ann. 74. 121. Annalen 68. 224. J. pr. Chem. 46. 318. Pharm. Centr. 1848. 401. Jahresb. 1. 383. Gmelin-Kraut 3. 650. (7) Annalen 125. 343. Jahresb. 16. 162. Gmelin-Kraut 3. 650.

*(1) Pogg. Ann. 74. 121. Annalen 68. 224. J. pr. Chem. 46. 318. Pharm. Centr. 1848. 401. Jahresb. 1. 383. (2) Ann. Chim. Phys. [3] 2. 87. Annalen 39. 338. (3) Pogg. Ann. 118. 282. J. pr. Chem. 86. 295. J. P. Chim. [3] 42. 341. Rep. Chim. pure. 5. 77. Jahresb. 15. 100. Gmelin-Kraut 3. 257. (4) Pogg. Ann. 118. 289. J. pr. Chem. 86. 295. J. P. Chim. [3] 42. 341. Rep. Ch. pure. 5. 77. Jahresb. 15. 100. Gmelin-Kraut 2. 1. 473. (5) Annalen 125. 341. Jahresb. 16. 160. (6) Compt. rend. 1845. July 7. Chem. Gaz., 3. 342.

Nickelous Nitrite. $Ni(NO_2)_2$.

Nickelous nitrite is not decomposed at 100°, J. Lang (7), but when heated to redness it loses its acid, and leaves behind the oxide of nickel, J. Lang (1).* W. Hampe (2).

Silver Nitrite. $AgNO_2$.

Silver nitrite does not lose in weight at 100°, but begins to decompose at 140–150°, J. Lang (3). When gently heated in a glass tube it decomposes into metallic silver and nitrous acid (4), or evolves hyponitric acid, which converts the residue into silver nitrate, Peligot (5). When silver nitrite is heated in an open dish over a lamp, or in an air bath, between 85 and 140°, it decomposes into metallic silver, tri-oxide of nitrogen and silver nitrate, a little of the nitrite remaining undecomposed, $3AgNO_2 = N_2O_3 + Ag_2 + AgNO_3$. When a closely covered crucible is used, there is formed nitric oxide instead of the tri-oxide of nitrogen, $2AgNO_2 = NO + Ag + AgNO_3$. When heated in a test tube, accurately stopped with a glass rob, red fumes appear at 115°; the crystals begin to shrink and fuse at 134°, and ½ the salt is decomposed into metallic silver, nitric oxide and oxigen, Ed. Divers (6).

Zinc Nitrite. $Zn(NO_2)_2 3H_2O$.

Zinc nitrite is decomposed even by a gentle heat, N. W. Fischer (1),† and when heated at 100° evolves nitric oxide and leaves a basic salt, which at a higher temperature loses its acid and is converted into the oxide, J. Lang (2). When Zinc nitrite is heated to redness the oxide remains, W. Hampe (3).

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(7) Pogg. Ann. 118. 282. J. pr. Chem. 86. 295. J. P. Chim. [3] 42. 341. Rep. Ch. pure. 5. 77. Jahresb. 15. 100. Gmelin-Kraut 3. 555.

*(1) Pogg. Ann. 118. 282. J. pr. Chem. 86. 295. J. P. Chim. [3] 42. 341. Rep. Ch. pure. 5. 7. Jahresb. 15. 100. (2) Annalen 125. Jahresb. 16. 160. (3) Pogg. Ann. 118. 118. 292. J. pr. Chem. 86. 295. J. P. Chim. [3] 42. 341. Rep. Ch. pure. 5. 77. Jahresb. 15. 100. Gmelin-Kraut 3. 952. (4) Gmelin-Kraut 3. 952. 1. 2. 459. (5) Ann. Chim. Phys, [3] 2. 68. Gmelin-Kraut 1. 2. 459. (6) Chem. Soc. J. 24. 85. Bull. Soc. Chim. [2] 15. 178. Ber. 4. 282. Amer. Chem. 2. 71. Jahresb. 24. 343.

†(1) Pogg. Ann. 74. 121. Annalen 68. 224. J. pr. Chem. 46. 318. Pharm. Chem. 1848. 401. Jahresb. 1. 383. (2) Pogg. Ann. 118. 289. J. pr. Chem. 86. 295. J. P. Chim. [3] 42. 341. Rep. Ch. pure. 5. 77. Jahresb. 15. 100. Gmelin-Kraut 3. 34. (3) Annalen 125, 344. Jahresb. 16. 160.

THE PHOSPHATES.

Aluminium Phosphate. $Al_2(PO_4)_2$.

Aluminium phosphate does not melt at a red heat, Ludwig (1).*

Ammonium Phosphate. $(NH_4)_3PO_4$.

Ammonium phosphate cannot be dried without losing ammonia and being converted into diammonic phosphate (2), which when heated first undergoes fusion, then dries up, and at a red heat is converted with slow and imperfect expulsion of ammonia into hydrated phosphoric acid (3), or into meta phosphoric acid, $(NH_4)_2HPO_4 = HPO_3 + 2NH_3 + H_2O$ (2).

Barium Phosphate.

Mono-basic phosphate of barium ($BaH_4(PO_4)_2$), when heated, melts to a colorless glass, Erlenmeyer (4), or by melting forms a white, spongy mass, similar to alum, and at a red heat leaves behind meta-phosphate of barium, Berzelius (5).

Di-basic phosphate of barium ($BaHPO_4$) melts in the heat, Berzelius (6), loses no water at 300°, and becomes anhydrous only at a red heat, A. Chodnew (7).

Cadmium Phosphate. $Cd_3(PO_4)_2$.

Cadmium phosphate melts at an incipient white heat forming a transparent vitreous mass, Stromeyer (1).†

Calcium Phosphate. $Ca_3(PO_4)_2$.

Normal phosphate of calcium can be melted at a very high red heat to a porcelain-like mass, Saussaure (2).

The precipitated salt retains 1 mol. of water at 100°, becomes anhydrous at 200°, and is not decomposed by simple ignition (3).

Mono-basic phosphate of calcium ($CaH_4(PO_4)_2$) melts when heated, giving off all its water and leaving an insoluble meta-phosphate (4), $CaH_4(PO_4)_2 = CaP_2O_6 + 2H_2O$ (5). The same with 1 mol. of water of crystallization ($CaH_4(PO_4)_2H_2O$) loses 17.2 per cent. of its water

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* (1) Arch. Pharm. [2] 59. 19. Pharm. Centr. 1850. 109. Gmelin-Kraut 2. 1. 632. (2) Watts Dict. 1. 193. (3) Gmelin. Watts Transl. 2. 442. (4) Jahresb. 10. 145. Gmelin-Kraut 2. 1. 273. (5) Ann. Chim. Phys. 2. 153. Gmelin-Kraut 2. 1. 274. (6) Gmelin-Kraut 2. 1. 272. (7) J. pr. Chem. 29. 201.

† (1) Ann. Chim. Phys. 11. 81. Gmelin-Kraut 3. 66. Watts Dict. 4. 554. (2) Gmelin-Kraut 2. 1. 366. (3) Watts Dict. 4. 556. (4) Watts Dict. 4. 555. (5)

at 200°, and is converted into pyro-phosphate of calcium and meta-phosphoric acid, $2CaH_4(PO_4)_2 \cdot H_2O = Ca_2P_2O_7 + H_2P_2O_6 + 5H_2O$, which by further heating swells up, melts, loses the rest of the water, and at a red heat is converted into meta-phosphate of calcium, K. Birnbaum (6).

Di-basic phosphate of calcium ($CaHPO_4$), when subjected to a red heat, loses water and is changed into a pyrophosphate, Debray (1).* The same with 2 mol. of water of crystallization ($CaHPO_4 \cdot 2H_2O$) loses the 2 mol. at 140°, Percy (2), or at 150°, and the last traces of waters at a red heat, Bödeker (3), leaving behind a somewhat porous, white, opaque mass, Erlenmeyer (4).

Chromium Phosphate. $Cr_2(PO_4)_2 \cdot 12H_2O$.

Phosphate of chromium with 12 mol. of water loses, when heated, 7 mol. of water and is converted into the green phosphate, A. Etard (5).

Cobaltous Phosphate.

Cobaltous phosphate is of a pink color, and when heated loses its water and becomes bluish-pink, Alvaro Reynoso (6).

Cupric Phosphate. $Cu_3(PO_4)_2 \cdot 3H_2O$.

Cupric phosphate changes in the heat from a bluish-green to a dark brown powder under loss of water (7).

Ferric Phosphate. $Fe_2(PO_4)_2 \cdot 4H_2O$.

Ferric phosphate, when heated, becomes yellow and melts at a red heat, Bergman (1),† becoming anhydrous, Millot (2).

Watts Dict. 4. 500. (6) Zeitschr. Chem. 1871. 137. Jahresb. 24. 281. Gmelin-Kraut 2. 1. 373.

*(1) Ann. Chim. Phys. [3] 61. 424. Gmelin-Kraut 2. 1. 371. (2) Watts Dict. 4. 555. (3) Annalen 69. 206. Pharm. Centr. 1849. 282. Chem. Gaz. 7. 138. Jahresb. 2. 229. (4) N. Jahrb. Pharm. 7. 225. Jahresb. 10. 145. (5) Compt. rend. 84. 1089. Gmelin-Kraut 2. 2. 304. Jahresb. 30. 261. (6) Ann. Chim. Phys. [3] 45. 110. (7) Gmelin-Kraut 3. 615.

†(1) Opusc. 3. 118. Gmelin-Kraut 3. 327. Watts Dict. 4. 563. (2) Compt. rend. 82. 89. Pharm. J. Trans. [3] 7. 118. Jahresb. 29. 244. Ros. and Sch.

Lead Phosphate.

Di-basic phosphate of lead ($PbHPO_4$), when heated to redness, remains white, gives off water, and changes into the anhydrous pyrophosphate, $Pb_2P_2O_7$ (3).

Magnesium Phosphate. $Mg_3(PO_4)_2 \cdot 5H_2O$.

Normal magnesium phosphate with 5 mol. of water melts at a white heat to a clear glass, Graham (4), Gregory (5), and becomes anhydrous on ignition (6).

Di-basic phosphate of magnesium with 14 mol. of water ($MgHPO_4 \cdot 14H_2O$) loses 8 mol. of water at 100°; 6 more at 176°, and yields its basic water at a stronger heat under the formation of the pyrophosphate, Graham (7).

Manganous Phosphate. $Mn_3(PO_4)_2 \cdot 7H_2O$.

Normal manganous phosphate with 7 mol. of water loses 4 mol. at 100°, Erlenmeyer and Heinrich (8), or at 110°–120°, and the last 3 only at a red heat, Heintz (9).

Mono-basic phosphate of manganese ($MnH_4(PO_4)_2 \cdot 2H_2O$), when heated at 100°, not only loses water, Erlenmeyer and Heinrich (1),* but also a part undergoes decomposition with the separation of phosphoric acid, which at a higher temperature volatilizes, E. Erlenmeyer and O. Heinrich (2). The salt loses at 110–120° on an average 13.15 per cent. of water, and at a red heat 12.91° per cent., Heintz (3).

Di-basic phosphate of manganese with 6 mol. of water ($Mn_2H_2(PO_4)_2 \cdot 6H_2O$), when heated at 100°, loses 22.24 per cent. of water, Erlenmeyer and Heinrich (4); at 110°, 23.27 per cent., Bödeker (5); at 110–120°, 22.47 per cent., Heintz (6); at 200° the 6 mol. are evolved, Heintz (6), and at a red heat pyrophosphate of manganese ($Mn_2P_2O_7$) is left, Bödeker (7), Debray (8).

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2. 2. 102. (3) Gmelin-Kraut 3. 227. (4) Gmelin-Kraut 2. 1. 445. (5) Annalen 54. 98. Gmelin-Kraut 2. 1. 455. (6) Watts Dict. 4 569. (7) Gmelin-Kraut 2. 1. 447. (8) Annalen 190. 208. Jahresb. 30. 255. (9) Pogg. Ann. 74. 449. 75. 174. Annalen 48, 257. Pharm. Centr. 1848. 657. J. Ph. Chim. [3] 14. 397. Chem. Gaz. 6. 488. Jahresb. 1. 342.

* (1) Annalen 190. 195. Chem. Soc. J. 33. 270. Jahresb. 30. 255. Gmelin-Kraut 2, 2. 474. (2) Annalen 190. 191. (3) Pogg. Ann. 74. 450. Gmelin-Kraut 2. 2. 474. (4) Annalen 190. 191. Gmelin-Kraut 2. 2. 474. (5) Annalen 69. 208. Pharm. Centr. 1849. 283. Gmelin-Kraut 2. 2. 474. (6) Pogg. Ann. 74. 450. Gmelin-Kraut 2. 2. 474. (7) Annalen 69. 308. Gmelin-Kraut 2. 2. 474. (8) Ann. Chin. Phys. [3] 6'. 453. Gmelin-Kraut 2. 2. 474.

Mercuric Phosphate. $Hg_3(PO_4)_2$.

Mercuric phosphate, when heated, cakes up and melts to a dark yellow liquid, opaque when cold; at a stronger heat metallic mercury, oxygen and phosphorous oxide are evolved and a residue is left behind, which is not only acid in reaction and insoluble in water, but also contains mercuric oxide, which by a still longer heating is completely volatilized, Trommsdorff (1)*. The dry salt melts, when heated, to a dark yellow glass (2).

Mercurous Phosphate. $Hg_6(PO_4)_2$.

Mercurous phosphate, when gently heated in a tube, evolves metallic mercury and leaves mercuric phosphate as a residue, Gerhardt (3).

Nickelous Phosphate. $Ni_3(PO_4)_2 \cdot 7H_2O$.

Nickelous phosphate with 7 mol. of water gives off water at a low red heat and becomes yellow, Rammelsberg (4); but after a long continued heat it becomes brown without loss in weight, Struve (5).

Potassium Phosphate. K_3PO_4.

Normal phosphate of potassium, when strongly heated, melts to an enamel-like mass (6).

Mono-basic phosphate of potassium (KH_2PO_4) undergoes no change at 200°; but when heated nearly to redness is converted without melting into the metaphosphate, Graham (7), or melts to a clear glass, which on cooling consists of mono-metaphosphate of potassium, KPO_3 (1)†.

Di-basic phosphate of potassium (K_2HPO_4) is converted into the pyro-phosphate by ignition, Graham (2).

Silver Phosphate. Ag_3PO_4.

Silver phosphate melts at a strong red heat, Berzelius (3), to a dark brown fluid, which on cooling becomes yellow, and which a portion by longer melting is transformed into pyrophosphate of

* (1) Gmelin-Kraut 3. 754. (2) Watts Dict. 4. 573. (3) Compt. rend. 1849. 225. Jahresb. 2. 288. Gmelin-Kraut 3. 753. Watts Dict. 4. 573. (4) Pogg. Ann. 68. 383. Gmelin-Kraut 3. 543. Watts Dict. 4. 544. (5) Gmelin-Kraut 3. 543. (6) Watts Dict. 4. 575. Ros. and Sch. 2. 1. 89. (7) Watts Dict. 4. 574.

† (1) Gmelin-Kraut 2. 1. 30. (2) Gmelin-Kraut 2. 1. 31. Watts Dict. 4. 575. (3) Gmelin-Kraut 3. 918. Watts Dict. 4. 576. Ros. and Sch. 2. 1. 379. Miller

silver, Stromeyer (4). When the salt is heated in a platinum crucible below redness, it deepens in color, becoming a dark orange-brown, but recovering its original color on cooling, Alvaro Reynoso, (5), Berzelius (6).

Di-basic phosphate of silver (Ag_2HPO_4) loses no water at 100°, but at 170° it loses 2.87 per cent. under the formation of pyrophosphate of silver, Schwarzenberg (7).

Sodium Phosphate. $Na_3PO_4 \cdot 12H_2O$.

Normal sodium phosphate with 12 mol. of water melts at 76.7° (1)*, retains 1 mol. of water at 100°, which it does not entirely yield at 200°; but gives it up at a red heat only after repeated pulverization and heating, Gerhardt (2), Graham (3).

Sodium phosphate with 10 mol. of water ($Na_3PO_4 \cdot 10H_2O$) melts at 100°, loses at 110° 48.70 per cent. of water, the rest of which, 2.46 per cent., is still retained at 150°, but is expelled at red heat, Rammelsberg (4).

Mono-basic phosphate of sodium ($NaH_2PO_4 \cdot 4H_2O$) loses its water of crystallization at 100°; at 190–204° it evolves $\frac{1}{2}$ its water of constitution. $2NaH_2PO_4 = NaH_2P_2O_7$; at 204–244° evolves the rest, forming mono-metaphosphate, $NaH_2PO_4 = NaPO_3 + H_2O$; and at a red heat there remains the hexa-meta phosphate of sodium, $Na_6P_6O_{18}$ (5). When the salt is quickly heated to 204°, the crystals partially melt, Graham (6).

Di-basic phosphate of Sodium ($Na_2HPO_4 \cdot 12H_2O$) melts at 35°. H. Kopp (7), or at 36.4, C. C. Person (8), loses its water of crystallization at 45° (1)† and at a red heat it is transformed into the pyrophosphate, Clark (2); this change takes place at 240°, and in fact

687. (4) Schw. 58. 126. Gmelin-Kraut 3. 918. (5) Ann. Chim. Phys. [3] 45. 110. Gmelin-Kraut 3. 918. Watts Dict. 4. 576. (6) Gmelin-Kraut 3. 918. (f) Annalen 65. 162. Gmelin-Kraut 3. 919.

* (1) Gmelin-Kraut 2. 1. 163. Ros. and Sch. 2. 1. 121. (2) J. Ph. Chim. [3] 12. 57. Jahresb. 1. 338. Gmelin-Kraut 2. 1. 163. (3) Gmelin-Kraut 2. 1. 163. (4) J. pr. Chem. 94. 237. Jehresb. 17. 185. Gmelin-Kraut 2. 1. 163. (5) Gmelin-Kraut 2. 1. 167. Watts Dict. 4. 579. Ros. and Sch. 2. 1. 123. (6) Gmelin-Kraut 2. 1. 167. (7) Annalen 93. 129. Pharm. Centr. 1855. 219. Instit. 1855. 260. Phil. Mag. J. [4] 9. 477. Jahresb. 8. 45. Gmelin-Kraut 2. 1. 165. Watts Dict. 4. 579. Ros. and Sch. 2. 1. 122. (8) Ann. Chim. Phys. [3] 27. 250. Pogg. Ann. 70. 301. Compt. rend. 23. 162. Annalen 64. 179. Jahresb. 1. 72. 2. 32. Gmelin-Kraut 2. 1. 165.

† (1) Ros. and Sch. 2. 1. 122. (2) Schw. 57. 428. Gmelin-Kraut 2. 1. 165.

the water cannot be driven off without the formation of the pyro-phosphate, Rose (3).

Strontium Phosphate.

Di-basic phosphate of Strontium ($SrHPO_4$) is converted at a red heat into the pyro-phosphate, $Sr_2P_2O_7$ (4).

Zinc Phosphate. $Zn_3(PO_4)_2 \cdot 2H_2O$.

Zinc phosphate with 2 mols. of water melts easily, forming a transparent, colorless liquid (5).

THE SULPHATES.

Aluminium Sulphate. $Al_2(SO_4)_3 \cdot 18H_2O$.

Aluminium sulphate, crystallized with 18 mol. of water, melts when heated in its water of crystallization (1)*, which it loses at 120° without changing in appearance, Hager (2), or under strong inflation, Berzelius (3), and at a red heat pure aluminium oxide remains. The anhydrous salt when heated to redness over a gas flame leaves the basic salt, $Al_4O_5SO_4$, Stolba (4).

Ammonium Sulphate. $(NH_4)_2SO_4$.

Ammonium sulphate decrepitates when heated (5), melts at 140° and begins to decompose at 280°, Marchland (6). At a temperature a little higher than the boiling point of mercury, ammonia and water are given off, while a mixture of the pyro-sulphate with the normal and acid sulphate is left, $6(NH_4)_2SO_4 = 5NH_3 + H_2O + 3NH_4HSO_4 + (NH_4)_2S_2O_7 + (NH_4)_2SO_4$. Near incipient redness the action is expressed by the following equation: $3[NH_4HSO_4 + (NH_4)_2S_2O_7 + (NH_4)_2SO_4] = 2SO_3 + 2H_2O + 3NH_3 + 2NH_4HSO_4 + (N_2H_4)_2S_2O_7$, S. W. Johnson and R. H. Crittenden (7).

At a little above the boiling of mercury ammonium sulphate loses ½ its ammonia, forming the bi-sulphate, $(NH_4)_2SO_4 = NH_4HSO_4 + NH_3$; and then below incipient redness it loses ammonia and

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Watts Dict. 4. 579. (3) Pogg. Ann. 76. 13. Gmelin-Kraut 2. 1. 165. (4) Gmelin-Kraut 2. 1. 325. (5) Watts Dict. 4. 587.

* (1) Watts Dict. 5. 579. Ros. and Sch. 2. 1. 449. (2) Pharm. Centr. 12. 476. Jahresb. Ph. Tox. 1871. 233. (3) Gmelin-Kraut 2. 1. 639. Watts Dict. 5. 579. Ros. and Sch. 2. 1. 449. (4) Chem. Centr. 1874. 135. Gmelin-Kraut 2. 1. 638. (5) Gmelin. Watts Transl. 2. 462. Miller 392. (6) Pogg. Ann. 40. 556. Gmelin. Watts transl. 2. 462. Watts Dict. 1. 193. Miller 392. (7) Amer. J. Sci. [3] 15. 131. Chem. Soc. J. 33 and 34 (Abs.) 373.

acid both, $4(NH_4HSO_4)=(NH_4)_2H_4(SO_4)_3+SO_2+2H_2O+4H$, Pau[1] Schweitzer (1).*

The salt after melting consists of the acid sulphate of ammonium, H. Rose (2). When the salt is heated in a retort a sublimate of the sulphite and sulphate is obtained, H. Rose (3); but before the sublimation takes place, ammonia, water and nitrogen are evolved (4).

Antimonous Sulphate. $Sb_2(SO_4)_3$.

Antimonous sulphate when heated to redness, gives off sulphuric anhydride, C. Schultz-Sellack (5), Bussy (6), or sulphurous anhydride and oxygen, Gay-Lussac (6), and often yields a sublimate of antimonic oxide in the form of needles, Birchloz (6).

Barium Sulphate. $BaSO_4$.

Barium sulphate melts at 35°, Wedgw., Saussaure (7), undergoes a partial decomposition when heated over a Bunsen-gas-bellows, and in Schlösing's apparatus at the melting heat of iron it not only loses all its acid, but also a portion of its baryta, Boussingault (1).†

Bismuth Sulphate. $Bi_2(SO_4)_3$.

Bismuth sulphate can be heated almost to redness without decomposition, C. Schultz-Sellack (2).

Cadmium Sulphate. $3CdSO_4 \cdot 8H_2O$.

Crystallized cadmium sulphate loses nearly 3 mol. of water at 100°, and the remainder at a dull red heat without melting and without loss of any acid, Carl von Hauer (3). When the anhydrous sulphate of cadmium is subjected to a strong red heat, $\frac{1}{2}$ its acid is expelled and a basic salt is left behind, Stromeyer (4), C. von Hauer (5). By long continued calcination a portion of the remaining acid is driven off; the mass is partially fused and appears brown from the formation of free oxide, C. von. Hauer (5), this residue consists of the oxide and neutral sulphate of cadmium, O. Follenius (6).

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* (1) Chem. News. 36. 95. (2) Pogg. Ann. 32. 85. (3) Pogg. Ann. 32. 85. Gmelin. Watts transl. 2. 462. (4) Gmelin. Watts transl. 2. 462. Watts Dict. 1. 193. (5) Ber. 4. 13. Jahresb. 24. 328. Watts Dict. sup. 2. 1137. (6) Gmelin. Watts transl. 4. 361. (7) Gmelin-Kraut 2. 1. 287.

† (1) Compt rend. 64. 1159. Instit. 1867. 185. Ann. Chim. Phys. [4] 12. 424. Bull. Soc. Chim. [2] 8. 259. J. pr. Chem. 102. 90. Zeitschr. Anal. Chem. 7. 244. Jahresb. 20. 151. Gmelin-Kraut 2. 1. 287. (2) Ber. 4. 13. Jahresb. 24. 329. (3) Wien. Akad. Ber. 15. 23. Chem. Soc. J. 8. 251. Gmelin-Kraut 3. 68. Watts. Dict. 5. 585. (4) Ann. Chim. Phys. 11. 80. Gmelin-Kraut. 3. 69. (5) Wien. Akad. Ber. 15. 23. Chem. Soc. J. 8. 251. Gmelin-Kraut 3. 69. (6) Zeitschr. Anal. Chem. 13. 276.

The crystallized sulphate when heated in a vacuum at 79° loses 5 mol. of water and becomes anhydrous at 110°, H. Precht and K. Kraut (1).*

Calcium Sulphate. $CaSO_4 \cdot 2H_2O$.

Powdered gypsum loses, although slowly, all its water at 100°, Kraut (2), even under 100°, Fr. Knapp (2), or does not lose any at 100°, T. Graham (3).

The crystallized sulphate of calcium loses $\frac{3}{4}$ of its water at 105–110°, Millon (4), at 110–115°, Plessy (5), or at 100–120° (6), and the whole is not expelled below 132°, T. Graham (3); but is given off at 200–250°, Plessy, (7), at 200–300°, Millon (4), or at 110–120° (8). The precipitated gypsum loses its water in a steam bath, Gunning (9), Millon (10), Plessy (11). The anhydrous salt when heated at a white heat in an open or covered crucible, loses acid and leaves a residue containing free calcium oxide, Alexander Mitscherlich (12); but when heated over a Bunsen-gas-bellows or in Schlösing's apparatus at the melting heat of iron, the whole of its acid is expelled, and a residue of calcium oxide remains, Boussingault (1).†

Chromium Sulphate. $Cr_2(SO_4)_3 \cdot 15H_2O$.

Chromium sulphate with 15 mol. of water melts at 100° in its water of crystallization (2), of which it loses 10 mol., being thereby converted into the green sulphate (3).

The salt with 18 mol. of water ($Cr(SO_4)_3 \cdot 18H_2O$) changes, when heated, under loss of 12 mol. into the green sulphate, which at an incipient redness becomes anhydrous, A. Etard, (4).

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* (1) Annalen 178. 140. (2) Gmelin-Kraut 2. 1. 386. (3) Phil. Mag. J. [3] 6. 422. Trans. Roy. Soc. Ed. 13. 297. Pogg. Ann. 38. 123. J. pr. Chem. 5. 80. (4) Ann. Chim. Phys. [3] 19. 222. J. pr. Chem. 40. 363. Pharm. Centr. 1847. 395. Phil. Mag. J. [3] 30. 299. Jahresb. 1. 395. (5) Compt. rend. 24. 658. Jahresb. 1. 395. (6) Watts Dict. 5. 585. (7) Compt. rend. 24. 658. Jahresb. 1. 395. Watts Dict. 5. 285. (8) Ros. and Sch. 2. 1. 202. (9) Chem. Centr. 1871. 148. Gmelin-Kraut 2. 1. 386. (10) Ann. Chim. Phys. [3] 19. 222. Compt. rend. 24. 695. Gmelin-Kraut 2. 1. 386. (11) Compt. rend. 24. 658. 812. Jahresb. 1. 395. Gmelin-Kraut 2. 1. 386. (12) J. pr. Chem. 83. 485. Zeitschr. Anal. Chem. 1. 63. Jahresb. 14. 843. Gmelin-Kraut 2. 1. 384.

† (1) Ann. Chim. Phys. [4] 12. 419. Compt. rend. 64. 1159. Zeitschr. Anal. Chem. 7. 244. Gmelin-Kraut 2. 1. 384. (2) Miller 539. (3) Watts Dict. 5. 588. Miller 539. (4) Compt. rend. 84. 1089. Chem. News. 35. 253. Jahresb. 30.

The green sulphate of chromium on exposure to heat changes to a rose color with a faint violet tint, but recovers its green color on cooling, M. E. Kopp (5).

Cobaltous Sulphate. $CoSO_4 \cdot 7H_2O$.

Cobaltous sulphate, when heated at 100° until it ceases to lose in weight, suffers a loss of 6 mol. of water, at 250° becomes anhydrous, T. E. Thorpe and John I. Watts (6). When it is heated the salt, without melting, but with loss of water, becomes opaque and rose red in color, Proust (1).*

Cupric Sulphate. $CuSO_4 \cdot 5H_2O$.

Crystallized sulphate of copper loses 4 mol. of water at 100°, T. Graham (2), and the last mol. at 200° (3), or at 221–242°. T. Graham (4). The anhydrous sulphate, when subjected to a dark red heat, loses $\frac{1}{2}$ of its acid forming a basic salt, Roucher (5) ; but at a strong red heat it loses all its acid, giving off sulphurous anhydride and oxygen, Gay-Lussac (6), together with some sulphuric anhydride, Bussy (7), and leaving cupric oxide (8).

Ferric Sulphate. $Fe_2(SO_4)_3$.

Ferric sulphate at a bright red heat evolves sulphuric anhydride (9), and leaves pure oxide of iron, Peter Hart (10).

Ferrous Sulphate. $FeSO_4 \cdot 7H_2O$.

Ferrous sulphate, when heated, melts in its water of crystallization (1),† 6 mol. of which are expelled at 114–115°, and the last mol. is retained even at 180°, T. Graham (2) ; but at a red heat it de-

261. Gmelin-Kraut 2. 2. 309. (5) Compt. rend. June 17. 1844. Chem. Gaz. 2. 381. (6) Chem. Soc. J. 37. 112.

* (1) Gmelin-Kraut 3. 452. (2) Phil. Mag. J. [3] 6. 418. Trans. Roy. Soc. Ed. 13. 297. J. pr. Chem. 5. 90. Pogg. Ann. 38. 123. Watts Dict. 5. 590. Ros. and Sch. 2. 1. 338. Miller 622. (3) Watts Dict. 5. 590. Miller 622. (4) Phil. Mag. J. [3] 5. 418. Trans. Roy. Soc. Ed. 13. 297. J. pr. Chem. 5. 90. Pogg. Ann. 38. 123. Gmelin-Kraut 3. 620. Ros. and Sch. 2. 1. 338. (5) J. Ph. Chim. [3] 37. 249. Zeitschr. Chem. Pharm. 1860. 462. Jahresb. 13. 193. Gmelin-Kraut 3. 629. (6) Gmelin-Kraut 3. 629. Watts Dict. 5. 590. (7) Gmelin-Kraut 3. 629. (8) Watts Dict. 5. 590. (9) Gmelin-Kraut 3. 346. (10) Chem. Gaz. 12. 350.

† (1) Gmelin-Kraut 3. 340. (2) Phil. Mag. J. [3] 6. 421. Trans. Roy. Soc. Ed.

composes, evolving sulphurous anhydride and leaving a basic sulphate, which at a higher temperature loses the whole of its acid, partly as sulphuric anhydride, and partly as sulphurous anhydride and oxygen, leaving a residue of ferric oxide (3). Ferrous sulphate loses 6 mol. of water when heated in a vacuum at 100°, H. Precht and K. Kraut (4), or at 140°, Mitscherlich (5), and can be rendered anhydrous if the heat be cautiously raised, T. Graham (6).

Lead Sulphate.. $PbSO_4$.

Lead sulphate melts at a red heat (7), without decomposition (8), becoming crystalline on cooling (9) ; does not decompose at a very strong heat, Berthier (10) ; but when subjected to a white heat in an open crucible over a gas-bellows it loses all its acid, Boussingault (11).

When heated in a tightly covered vessel lead sulphate undergoes no change ; but in an open or loosely covered one it suffers a change of color and loss in weight, Erdmann (1),* O. L. Erdmann and R. E. Marchland (2).

Magnesium Sulphate. $MgSO_4 \cdot 7H_2O$.

Magnesium sulphate, when heated, melts in its water of crystallization (3), 1 mol. of which it loses at 40°, Mulder (4), or at 50° (5), 3.5 mol. at 60°, 5 mol. at 101°, 6 mol. at 201°, Mulder (4), at 131°, T. Graham (6), or at 150° (7), and the last mol. is retained at 130–140°, T. E. Thorpe and J. I. Watts (8), at 200° (7), or at 238. T. Graham (6), being expelled at 280°, T. E. Thorpe and J. I. Watts (8), or at 285° in the vacuum of Hofmann's apparatus, Ad. Schröder (9).

13. 297. J. pr. Chem. 5. 90. Pogg. Ann. 38. 123. Gmelin-Kraut 3. 339. Watts Dict. 5. 597. (3) Gmelin-Kraut 3. 339. Watts Dict. 5. 597. Miller 522. (4) Annalen 178. 140. (5) Gmelin-Kraut 3. 339. (6) Phil. Mag. J. [3] 6. 421. Pogg. Ann. 38. 123. J. pr. Chem. 5. 90. Gmelin-Kraut 3. 339. Ros. and Sch. 2. 2. 95. (7) Gmelin-Kraut 3. 236. Ros. and Sch. 2. 1. 288. (8) Ros. and Sch. 2. 1. 288. (9) Gmelin-Kraut 3. 236. (10) Ann. Chim. Phys. 20. 275. Gmelin-Kraut. 3. 235. (11) Compt. rend. 44. 1159. Ann. Chim. Phys. [4] 12. 426. Instit. 1867. 185. Bull. Soc. Chim. [2] 8. 259. J. Ph. Chim. [4] 7. 112. J. pr. Chem. 102. 90. Zeitschr. Anal. Chem. 7. 244. Jahresb. 20. 151. Gmelin-Kraut 3. 235. Watts Dict. Sup. 1. 1072.

* (1) J. pr. Chem. 62. 381. Jahresb. 7. 361 Gmelin-Kraut 3. 235. (2) J. pr. Chem. 31. 397. (3) Ros. and Sch. 2. 1. 244. (4) Scheik. Verh. 1864. 53. Gmelin-Kraut 2. 1. 459. (5) Miller 453. (6) Phil. Mag. J. [3] 6. 421. Trans. Roy. Soc. Ed. 13. 297. J. pr. Chem. 5. 90. Pogg. Ann. 38. 123. Gmelin-Kraut 2. 1. 455. (7) Watts Dict. 5. 600. Ros. and Sch. 2. 1. 244. Miller 453. (8) Chem. Soc. J. 37. 106. (9) Ber. 4. 471. Gmelin-Kraut 2. 1. 459.

Anhydrous magnesium sulphate withstands a moderate red heat without decomposition, but when subjected to a three hours heating at strong redness, it loses ¼ its acid ; and after longer heating the insoluble residue, when treated with acids, evolves hydrosulphuric acid gas, Daubeny (1).*

When the anhydrous salt is subjected to a white heat over a Bunsen-gas-bellows in an open or covered crucible, or to the melting heat of iron in Schlösing's apparatus, it loses the whole of its acid, and leaves a residue of magnesia, Boussingault (2). Small quantities of the sulphate are always decomposed at a cherry red heat under the formation of magnesia, Gay-Lussac (4).

Manganic Sulphate. $Mn_2(SO_4)_3$.

Manganic sulphate can be heated to 160° with loss of oxygen or acid ; but at a red heat it loses oxygen and sulphuric anhydride, and is converted into manganous sulphate, Carius (3).

Manganous Sulphate. $MnSo_4 \cdot 7H_2O$.

Manganous sulphate with 7 mol. of water of crystallization loses 4.9 per cent. of its water when heated between 9 and 11° ; 18.6 per cent. between 12.5 and 15° and at 19° it melts under the separation of a salt containing 2 mol. of water, Brandes (1).† The salt with 5 mol. of water ($MnSO_4 \cdot 5H_2O$) loses 4 mol. at 100°, T. E. Thorpe and J. I. Watts (2), or at 210°, T. Graham (3), 29.87 per cent. at 150°, Petterson (4), and becomes anhydrous at 200°, T. Graham (5), at 280°, T. E. Thorpe and J. I. Watts (6), or at a red heat (7).

The salt with 4 mol. of water ($MnSO_4 \cdot 4H_2O$), when heated, decomposes without melting and forms a white powder, Brandes (8). Anhydrous manganous sulphate withstands an incipient red heat without decomposition ; but at a stronger redness it evolves oxygen,

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*(1) Ed. Phil. J. 7. 111. Gmelin-Kraut 2. 1. 455. (2) Compt. Rend. 64. 1159. Ann. Chim. Phys. [4] 12. 419. Bull. Soc. Chim. [2] 8. 259. Instit. 1867. 185. J. pr. Chem. 102. 90. Zeitschr. Anal. Chem. 7. 244. Jahresb. 20. 151. Gmelin-Kraut 2. 1. 287. (3) Ann. Chim. Phys. [2] 13. 310. [4] 12. 419. (4) Annalen 98. 60. Gmelin-Kraut 2. 2. 489.

†(1) Pogg. Ann. 20. 556. Gmelin-Kraut 2. 2. 487. (2) Chem. Soc. J. 37. 113. (3) Phil. Mag. J. [3] 6. 420. Trans. Roy. Soc. Ed. 13. 297. J. pr. Chem. 5. 90. Pogg. Ann. 38. 123. (4) Nova Acta R. Soc. Scient. 1879. (5) Ros. and Sch. 2. 2. 8. (6) Chem. Soc. J. 37. 113. Gmelin-Kraut 2. 2. 485. (7) Gmelin-Kraut

sulphurous anhydride and sulphuric anhydride, and leaves manganoso-manganic oxide (9).

Mercuric Sulphate. $HgSO_4$.

Mercuric sulphate, when gently warmed, becomes yellow and afterwards of a reddish color, and decomposes when strongly heated into mercury, sulphurous anhydride, mercurous sulphate and oxygen, Mohr (10).

Mercurous Sulphate. Hg_2SO_4.

Mercurous sulphate melts at a dull red heat, Gay-Lussac (1), to a deep red-brown liquid, which on cooling forms a crystalline mass, Städeler (2).

The salt evolves immediately on melting a mixture of 103 parts of sulphurous anhydride and 97 parts of oxygen, while metallic mercury with a little sulphate and a very little sulphuric acid goes over undecomposed, Gay-Lussac (1).* Mercurous sulphate, when strongly heated, sublimes under partial decomposition to metallic mercury and mercuric sulphate, Städeler (3).

Nickelous Sulphate.—$NiSO_4 \cdot 7H_2O$.

Nickelous sulphate with 7 mol. of water loses at 100° about 4 mol., Carl von Hauer (4), or 6 mol., T. E. Thorpe and J. I. Watts (5) and at 103.3° 6 mol., T. Graham (6), becoming anhydrous at 250°, T. E. Thorpe and J. I. Watts (7), or at 279.4°, Graham (8). The salt with 6 mol. of water when heated to 200–250°, becomes greenish-yellow, and gradually loses all its water (1) ;† at a higher temperature sulphuric acid is expelled; but it is difficult to drive off the last traces of acid even at an incipient white heat, Pierre (2).

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2. 2. 485. (8) Pogg. Ann. 20. 556. Gmelin-Kraut 2. 2. 486. (9) Gmelin-Kraut 2. 2. 485. (10) Gmelin-Kraut 3. 763. Ros. and Sch. 2. 1. 407.

*(1) N. Gehl. 4. 469. Gmelin-Kraut 3. 762. (2) Annalen 87. 129. Pharm. Centr. 1853. 785. J. pr. Chem. 61. 471. Jahresb. 6. 387. Gmelin-Kraut 3. 762. Ros. and Sch. 2. 1. 401. (3) Annalen 87. 129. Pharm. Centr. 1853. 785. J. pr. Chem. 61. 471. Jahresb. 6. 387. (4) Wien. Akad. Ber. 39. 305. Gmelin-Krauf 3. 549. (5) Chem. Soc. J. 37. 110. Ros. and Sch. 2. 2. 151. (6) Gmelin-Kraut 3. 549. (7) Chem. Soc. J. 37. 110. (8) Gmelin-Kraut 3. 549. Ros. and Sch. 2. 2. 151.

† (1) Ann. Chim. Phys. [3] 16. 252. Gmelin-Kraut 3. 550. (2) Ann. Chim.

The anhydrous salt, when heated to a gentle redness, leaves, without melting, but with loss of acid, a basic salt, and at a red heat loses almost all its acid (3).

Potassium Sulphate. K_2SO_4.

Potassium sulphate, when heated, decrepitates strongly (4), and melts at a bright red heat (5), or at a cherry red heat, Jacquelain (6). When a small quantity of the sulphate is subjected to a white heat, either in an open or covered crucible, it loses in weight, leaving an alkaline residue, Alexander Mitscherlich (7).

When the salt is heated in an open crucible over a Bunsen-gas-bellows at a temperature at which silicates are decomposed, it loses in weight and leaves an alkaline residue ; but when heated in Schlösing's apparatus at the temperature of melting iron, it loses $\frac{2}{3}$ of its original weight in 20 minutes, and in 30 minutes is entirely volatized, Boussingault (1).*

Silver Sulphate. Na_2SO_4.

Silver sulphate decrepitates at 300° (2), melts at 654°, Thomas Carnelley (3), or at a dark red heat, and at a very high temperature is reduced with the evolution of sulphurous anhydride and oxygen, to metallic silver (4).

Sodium Sulphate. Na_2SO_4.

Sodium sulphate melts at 861°, Thomas Carnelley (3), or at 1280°, Braun (5), and at a strong red heat becomes a clear liquid, which on cooling forms a transparent laminated mass, Karsten (6). When the salt is heated in an open or covered crucible for 5 minutes at a white heat it loses in weight and leaves a residue only slightly alkaline in reaction, Alexander Milscherlich (7).

Sodium sulphate at a white heat in Schlösing's apparatus vapor-

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Phys. [3] 16. 252. (3) Gmelin-Kraut 3. 548. (4) Miller 338. (5) Watts Dict. 5. 607. (6) Ann. Chim. Phys. 70. 319. (7) J. pr. Chem. 83. 485. Zeitschr. Anal. Chem. 1. 63.

* (1) Compt. rend. 64. 1159. Ann. Chem. Phys. [4] 12. 427. Instit. 1867. 185. Bull. Soc. Chim. [2] 8. 259. J. pr. Chem. 102. 90. Zeitschr. Anal. Chem. 7. 244. J. Ph. Chim. [4] 7. 112. Jahresb. 20. 151. Gmelin-Kraut 2. 1. 43. (2) Gmelin-Kraut 3. 926. (3) Chem. Soc. J. 33. 273. (4) Gmelin-Kraut 3. 926. Watts Dict. 5. 609. Ros. and Sch. 2. 1. 376. (5) Pogg. Ann. 154. 190. (6) Gmelin-Kraut 2. 1. 182. (7) J. pr. Chem. 83. 485. Zeitschr. Anal. Chem. 1. 63.

izes, boiling at the melting heat of iron; and by incomplete volatilization the residue has a sharp alkaline reaction, Boussingault (1).*

Stannous Sulphate. $SnSO_4$.

Stannous sulphate decomposes at a red heat and leaves stannic oxide, Gay-Lussac (2), Bouquet (3).

Strontium Sulphate. $SrSO_4$.

Strontium sulphate melts at a violent heat to a glassy mass (4). When the salt is subjected to the temperature of melting iron in Schlösing's apparatus, it not only loses all its acid, but also some of the strontia formed is volatilized, Boussingault (5). Sulphate of strontia loses sulphuric acid when strongly ignited, Darmstadt (6), and leaves the pure oxide behind, Darmstadt (7).

Zinc Sulphate. $ZnSO_4{\cdot}7H_2O$.

Crystallized zinc sulphate melts when heated (8), loses 6 mol. of its water at 100°, T. Graham (9), Kühn (10), Van Der Zoon (11), or at 100–110°, T. E. Thorpe and J. I. Watts (1),† becomes anhydrous at a temperature above 110°, Van Der Zoon (2), at 238°, T. Graham, (3), at about 260°, (4), at 280–300°, T. E. Thorpe and J. I. Watts (1), at a moderate red heat (5), or at 118° in a stream of hot air, Pierre (6). The anhydrous salt at the fusing heat of silver decomposes into sulphurous anhydride and oxygen, leaving a residue, which consists of 99.3 per cent. of zinc oxide and 7 per cent. of zinc sulphate, H. Deville and H. Debray (7), and at a bright red heat

*(1.) Compt. rend. 64. 1159. Ann. Chim. Phys. [4] 12. 427. Instit. 1867. 185. Bull. Soc. Chim. [2] 8. 259. J. pr. Chem. 102. 90. Zeitschr. Anal. Chem. 7. 244. Jahresb. 20. 151. Gmelin-Kraut 2. 1. 182. (2) Gmelin-Kraut 3. 119. (3) J. Ph. Chim. [3] 11. 459. Annalen 64. 278. Jahresb. 1. 436. Gmelin-Kraut 3. 119. (4) Gmelin-Kraut 2. 1. 329. (5) Compt. rend. 64. 1159. Ann. Chim. Phys. [4] 12. 427. Instit. 1867. 185. Bull. Soc. Chim. [2] 8. 259. J. pr. Chem. 102. 90. Zeitschr. Anal. Chem. 7. 244. Jahresb. 20. 151. Gmelin-Kraut 2. 1. 329. (6) Bull. Soc. Chim. 1869. No. 2. Chem. News 19. 322. (7) Zeitschr. Anal. Chem. 6. 376. Jahresb. 20. 152. (8) Ros. and Sch. 2. 1. 262. Miller 467. (9) Phil. Mag. J. [3] 6. 33. Trans. Roy. Soc. Ed. 13. 297. J. pr. Chem. 5. 90. Pogg. Ann. 38. 123. Gmelin-Kraut 3. 24. Watts Dict. 5. 617. (10) Gmelin-Kraut 3. 24. (11) Berzelius' Jahresb. 15. 179. Gmelin-Kraut 3. 24.

†(1) Chem. Soc. J. 37. 108. (2) Berzelius' Jahresb. 15. 179. Gmelin-Kraut 3. 23. (3) Phil. Mag. J. [3] 6. 33. Trans. Roy. Soc. Ed. 13. 297. J. pr. Chem. 5. 90. Pogg. Ann. 38. 123. Gmelin-Kraut 3. 23. (4) Watts Dict. 5. 617. (5) Gmelin-Kraut 3. 24. Ros. and Sch. 2. 1. 262. (6) Ann. Chim. Phys. [3] 16. 241. (7)

(8), or at a white heat (9), it is entirely decomposed, leaving a residue of zinc oxide (10). When a crystal of the prismatic form is heated to over 52°, it soon changes into an aggregation of small crystals of the same composition, Wilhelm Haidinger (11), or else containing only 6 mol. of water, Mitscherlich (12).

THE SULPHIDES.

Aluminium Sulphide. Al_2S_3.

Aluminium sulphide is difficultly fusible, forming thereby a hard crystalline mass. When it is heated in the air it burns, sulphurous anhydride being evolved and the oxide left as a residue, Friedrich Gustav Reichel (1).*

Ammonium Sulphide. $(NH_4)_2S$.

Ammonium sulphide even at an ordinary temperature is at once decomposed, losing ammonia and being converted into the hydrosulphide (2).

Antimonous Sulphide. Sb_2S_3.

Antimonous sulphide is easily fusible (3) and melts below a red heat (4). When roasted in the open air it burns, yielding sulphurous anhydride, antimonous and antimonic oxide (5) ; or is converted into a mixture of the oxide and sulphide of antimony (4) ; but at a high temperature it produces sulphurous anhydride and antimonous oxide (6). It boils at a strong red heat (3), and can be distilled unchanged in closed vessels (7). The red crystalline sulphide of antimony, when heated at 180°, becomes dark, but recovers its original color again on cooling ; while at 200° it is converted into the black modification, H. Rose (8). When the crystalline salt is kept in a state of fusion for some time and then thrown into cold water, it becomes amorphous and on the other hand the amorphous,

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Ann. Chim. Phys. [3] 61. 123. Compt. rend. 51. 822. Instit. 1860. 387. Dingl. pol. J. 159. 50. Annalen 117. 295. Zeitschr. Chem. Pharm. 1861. 19. Jahresb. 14. 53. Gmelin-Kraut 3. 18. (8) Watts Dict. 5. 617. (9) Ros. and Sch. 2. 1. 262. (10) Watts Dict. 5. 617. Ros. and Sch. 2. 1. 262. (11) Pogg. Ann. 11. 176. (12) Gmelin-Kraut 3. 24.

*(1) J. pr. Chem. 120. 55. Amer. Chemist. 6. 233. (2) Watts Dict. 1. 194. (3) Gmelin Watts Transl. 4. 337. (4) Miller 599. (5) Gmelin Watts Transl. 4. 338. Watts Dict. 1. 332. (6) Gmelin Watts Tranns. 4. 338. (7) Gmelin Watts Transl. 4. 338. Miller 599. (8) Pogg. Ann. 89. 122. Annalen 88. 257.

when melted and allowed to cool slowly, becomes crystalline, Joh. Nep. Fuchs (1).*

Antimonic Sulphide. Sb_2S_5.

Antimonic sulphide, when heated in a closed vessel to the boiling point of sulphur is resolved into the tri-sulphideand free sulphur, A. Mitscherlich (2). It swells up in the fire and burns with a flame, A. Vogel (3).

Arsenic Sulphide. As_2S_5.

Arsenic sulphide is fusible and can be sublimed without decomposition when the air is excluded (4).

Arsenious Sulphide. As_2S_3.

Arsenious sulphide is easily fusible, and if access of air be prevented it volatilizes undecomposed (5) ; it boils at about 700°, A. Mitscherlich (6). The salt when heated in the air burns and sulphurous anhydride is evolved, Charles W. Vincent (7), together with the trioxide of arsenic (8).

Barium Sulphide. BaS.

The anhydrous barium sulphide remains almost unchanged, when roasted, Berthier (1).† Barium sulphide with 6 mol. of water ($BaS \cdot 6H_2O$), when heated between 100° and 350°, loses its water of crystallization together with some hydro-sulphuric acid ; at a higher temperature it evolves hydro-sulphuric acid and sulphur, leaving a residue, which consists of the sulphide and sulphate of barium with traces of sulphite, Schöne (2).

Bismuth Sulphide. Bi_2S_3.

When the tri-sulphide of bismuth is heated in closed vessels, it is decomposed into a sub-sulphide and free sulphur, which distills (3) ; in the open air sulphurous anhydride escapes and bismuthic oxide remains (4). At each successive fusion of the artificial sulphide

* (1) Pogg. Ann. 31. 578. Gmelin. Watts Transl. 4. 340. (2) Gmelin. Watts Transl. 4. 357. Watts Dict. 1. 334. Ros. and Sch. 2. 2. 323. (3) Gmelin. Watts Transl. 4. 357. (4) Ros. and Sch. 1. 533. Miller 585. (5) Gmelin. Watts Transl. 4. 273. Ros. and Sch. 1. 532. Miller 584, (6) Gmelin. Watts Transl. 4. 273. Ros. and Sch. 1. 532. (7) Phil. Mag. J. [4] 14. 127. (8) Ros. and Sch. 1. 532.

† (1) Ann. Chim. Phys. 22. 231. Gmelin-Kraut. 2. 1. 277. (2) Pogg. Ann. 112. 193. Zeitschr. Chem. Pharm. 1861. 429. Rep. Chim. pure. 3 468. Jahresb. 14. 122. Gmelin-Kraut 2. 1. 278. (3) Gmelin. Watts Transl. 4. 435.

globules of metallic bismuth separate from the solidifying mass, Marx (5).

Cadmium Sulphide. CdS.

Cadmium sulphide melts at an incipient red heat and is non-volatile at any temperature, Stromeyer (6).

The salt on being heated assumes at first a brown color and afterwards a crimson, which it loses on cooling, Stromeyer (1).* When cadmium sulphide is heated over 100° in stream of air its color grows a darker red as the temperature rises ; and at no temperature does it decompose or volatilize ; while, however, it oxidizes on the surface when the heat is continued for a long time at over 135–140°, O. Follenius (2).

Calcium Sulphide. CaS.

Calcium sulphide cannot be melted at a white heat, and is almost unchanged by roasting, Berthier (3).

Chromium Sulphide.

Chromium sulphide when strongly heated in the air burns, evolving sulphurous anhydride and leaving the green oxide behind, J. L. Lassaigne (4), H. Moissan (5), Traube (6), Schafrik (6), or a green basic sulphate, W. Müller (7); but when heated in a closed vessel a portion of the sulphur is driven off in a free state, H. Moissan (5).

Cupric Sulphide. CuS.

Cupric sulphide when heated to redness with the exclusion of the air changes into cuprous sulphide, $\frac{1}{2}$ of its sulphur volatilizing, Dobereiner (1),† Spencer Pickering (2).

Miller 605. (5) Schw. 58. 472. 59. 114. Gmelin. Watts Transl. 4. 435. (6) Ann. Chim. Phys. 11. 82. Gmelin-Kraut 3. 66, 67. Watts Dict. 1. 706. Ros. and Sch. 2. 1. 268. Miller 469.

* (1) Ann. Chim. Phys. 11. 82. (2) Zeitschr. Anal. Chem. 13. 421. (3) Ann. Chim. Phys. 22. 233. Gmelin–Kraut 2. 1. 377. (4) Ann. Chim. Phys. 14. 300. Gmelin-Kraut 2. 2. 305. Ros. and Sch. 2. 2. 180. (5) Compt. rend. 90. 817. Chem. Soc. J. 38. 527. (6) Gmelin-Kraut 2. 2. 305. (7) Pogg. Ann. 127. 404. Chem. Centr. 1866. 561. Zeitschr. Chem. 1866. 257. Bull. Soc. Chim. [2] 6. 441. Jahresb. 19. 120. Gmelin-Kraut 2. 2. 305.

†(1) Schw. 17. 414. Gmelin-Kraut 3. 619. Ros. and Sch. 2. 1. 343. Chem.

When subjected to heat in the air it acts like cuprous sulphide (3).

Cuprous Sulphide. Cu_2S.

Cuprous sulphide is easily fusible in a closed vessel (4), and when heated out of contact with air decomposes into metallic copper and cupric sulphide, Hittorff (5); while according to others it does not change (6). When it is subjected to heat in the open air, combustion takes place and sulphurous anhydride and free cupric oxide are formed (7); or in addition some cupric sulphate (8).

Ferric Sulphide. Fe_2S_3.

Ferric sulphide when subjected to a strong red heat is converted, under loss of sulphur, into the di-sulphide, Berzelius (9), or into ferrous sulphide, Rammelsberg (9).

Ferrous Sulphide. FeS.

Ferrous sulphide at a gentle heat in the air is partially converted into ferrous sulphate, while at a stronger heat sulphurous anhydride is evolved and ferric oxide remains (1).*

It does not lose sulphur when heated to whiteness in absence of air, Berthier (2).

Lead Sulphide. PbS.

Sulphide of lead melts at a strong red heat, vaporizes at a stronger heat, and sublimes unchanged if the air be excluded, Rodwell (3). When gently heated in the air sulphurous anhydride is evolved, while metallic lead and lead sulphate remain behind, Descotils (4). If the sulphide be heated at 125–150° until sulphurous anhydride begins to appear and then the heat discontinued, a sulphite is formed and not a sulphate as is usually supposed, F. Rodwell (5).

Magnesium Sulphide. MgS.

Magnesium sulphide is quite infusible at the usual temperature

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Soc. J. 39. 406. (3) Miller 619. (4) Miller 618. (5) Pogg. Ann. 84. 1. Gmelin-Kraut 3. 617. (6) Gmelin-Kraut 3. 617. (7) Watts Dict. 2. 74. (8) Gmelin-Kraut 3. 617. Miller 619. (9) Gmelin-Kraut 3. 333.

*(1) Gmelin-Kraut 3. 329. Watts Dict. 3. 400. Ros. and Sch. 2. 2. 118. (2) Gmelin-Kraut 3. 330. Ros. and Sch. 2. 2. 118. (3) Gmelin-Kraut 3. 232. (4) Ann. Chim. Phys. 55. 441. Gmelin-Kraut 3. 230. Watts Dict. 3. 558. (5)

of furnaces, Friedrich Gustav Reichel (6); but burns in the air. F. G. Reichel (7).

Manganous Sulphide. MnS.

Manganous sulphide is not changed by strong heating in a closed tube, Clermont and Guiot (8); but when heated in the air it easily gives off all its sulphur as sulphurous anhydride and leaves manganoso-manganic oxide, Arfoedson (1).*

Manganous sulphide with 1 mol. of water ($MnS \cdot H_2O$) is not changed by being heated in a closed tube at 300°, Clermont and Guiot (2); but when it is heated to redness in a retort it is decomposed into water and the anhydrous salt, Berzelius (3), while in the air it evolves sulphurous anhydride and forms manganous sulphate and manganic oxide, Clermont and Guiot (4).

Mercuric Sulphide. HgS.

Mercuric sulphide when heated in the air burns with the formation of sulphur di-oxide and metallic mercury (5).

Cinnabar or vermillion becomes brownish when gently heated, quite brown at 250° and black at a higher temperature, but on cooling again assumes its scarlet-red color, Fickentscher (6). When moderately heated out of contact with the air the amorphous sulphide is formed, while at a stronger heat the red is again produced, Sequin (7). When powdered vermillion is heated in a small glass retort over a spirit lamp until a portion sublimes and then thrown into cold water it is converted into the black sulphide, Joh. Nep. Fuchs (1).† Cinnabar sublimes before undergoing fusion and forms a yellowish-brown vapor (2).

The black or amorphous sulphide is changed by sublimation into the red, Joh. Nep. Fuchs (3).

Mercurous Sulphide. Hg_2S.

Mercurous sulphide at a gentle heat is resolved into a mixture of

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Chem. Soc. J. 16. 46. Gmelin-Kraut 3. 230. (6) J. pr. Chem. 120. 55. Amer. Chem. 6. 233. Ros. and Sch. 2. 1. 248. (7) J. pr. Chem. 120. 55. Amer. Chem. 6. 233. (8) Gmelin-Kraut 2. 2. 282.

*(1) Gmelin-Kraut 2. 2. 478. Watts Dict. 3. 817. (2) Ann. Chim. Phys. [5] 12. 111. Compt. rend. 84. 653. Bull. Soc. Chim. [2] 27. 353. Jahresb. 30. 256. Gmelin-Kraut 2. 2. 478. (3) Gmelin-Kraut 2. 2. 478. (4) Compt. rend. 85. 73. Gmelin-Kraut 2. 2. 480. (5) Gmelin-Kraut 3. 758. Watts Dict. 3. 912. Miller 654. (6) Gmelin-Kraut 3. 758. Watts Dict. 3. 912. (7) Ann. Chim. 90. 268. Gmelin-Kraut 3. 759.

†(1) Pogg. Ann. 31. 581. (2) Miller 652. (3) Pogg. Ann. 31. 581. Gmelin-

mercuric sulphide and metallic mercury (4). At a stronger heat it yields a sublimate first of metallic mercury and afterwards of cinnabar (5).

Potassium Sulphide. K_2S.

Potassium sulphide burns very slowly in the air when heated to redness, since a film of sulphate is formed on the surface, Berthier (6), Bergelius (7).

The red sulphide becomes darker in the heat and melts below redness to a dark opaque fluid, Berzelius (8).

The flesh-colored sulphide will vaporize at a red heat, Berthier (6).

Silver Sulphide. Ag_2S.

Silver Sulphide is easily fusible and if heated in a closed vessel may be melted without becoming decomposed (1) ;* but if heated in the air it is converted into sulphurous anhydride and metallic silver, while at a gentle roasting there is also formed some sulphate of silver, Larranaga (2).

Sodium Sulphide. Na_2S.

Sodium sulphide becomes yellow by melting (3). If it has turned yellow by exposure to air it will by heating become white again, J. Kolb (4).

Stannic Sulphide. SnS_2.

Stannic sulphide, when ignited in a closed vessel, is resolved into sulphur and stannous sulphide, a portion, however, subliming unchanged (5) ; but when heated in contact with the air, it yields sulphurous anhydride and stannic oxide, Gay-Lussac (6), Berzelius (6).

Zinc Sulphide. ZnS.

Zinc sulphide does not fuse when heated (7) or only at a very high temperature, Deville and Troost (8). It does not vaporize at

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Kraut 3. 756, 760. Watts Dict. 3. 912. Miller 654. (4) Watts Dict. 3. 912. (5) Watts Dict. 3. 913. Miller 653. (6) Ann. Chim. Phys. 22. 233. Gmelin-Kraut 2. 1. 33. (7) Gmelin-Kraut 2. 1. 33. (8) Gmelin-Kraut 2. 1. 33. Ros. and Sch. 2. 1. 97.

*(1) Miller 682. (2) Gilb. Ann. 22. 304. Gmelin-Kraut 3. 922. Miller 682. (3) Gmelin-Kraut 2. 1. 174. (4) Ann. Chim. Phys. [4] 10. 106. Gmelin-Kraut 2. 1. 174. (5) Gmelin-Kraut 3. 116. Watts Dict. 5. 822. Ros. and Sch. 2. 2. 252. (6) Gmelin-Kraut 3. 117. Watts Dict. 5. 822. (7) Miller 466. (8) Compt.

a white heat, Deville and Troost (8), but does at the very highest temperature attainable, Sidot (9).

When the salt is heated in the air it oxidizes slowly, sulphurous anhydride being evolved, and the oxide and sulphate of zinc left behind (10). At a low temperature some sulphate is formed, but at a high heat only the oxide is left (11).

THE SULPHITES.

Aluminium Sulphite. $Al_2(SO_3)_2 \cdot 4H_2O$.

Aluminium sulphite when exposed to a temperature of 100° gives off sulphurous anhydride, Gougginsberg (1),* and when heated uninterruptedly for a long time at a strong redness loses all its acid and leaves behind pure aluminium oxide, Gougginsberg (2), J. S. Muspratt (3); but when heated for only a short time the residue is found to contain some sulphate, Foucroy and Vanquelin (4).

Ammonium Sulphite. $(NH_4)_2SO_3$.

Ammonium sulphite, when heated, decrepitates slightly, becomes soft without fusing (5), loses water and afterwards a large amount of ammonia, and at a higher temperature sublimes in the form of a silky mass, J. S. Muspratt (6).

Barium Sulphite. $BaSO_3$.

Barium sulphite at a gentle heat decrepitates and at a higher temperature evolves water, sulphurous anhydride and sulphur, J. S. Muspratt (7). When it is heated to redness in a closed vessel, it is resolved into a mixture of the sulphide and sulphate of Barium, $4BaSO_3 = BaS + 3BaSO_4$, C. Rammelsberg (8), Forester (9).

Bismuth Sulphite. $Bi_2(SO_3)_3$.

Bismuth sulphite loses nearly its whole acid in the heat, J. S. Muspratt (1).†

Cadmium Sulphite. $CdSO_3$.

Cadmium sulphite gives off sulphurous oxide in the heat, and leaves a yellow residue consisting of oxide, sulphite and sulphate of cadmium, C. Rammelsberg (2).

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rend. 52. 920. Gmelin-Kraut 3. 18. (9) Compt. rend. 63. 188. Gmelin-Kraut 3. 18. (10) Gmelin-Kraut 3. 18. (3) Miller 466.

*(1) Annalen 45. 132. Gmelin-Kraut 2. 1. 635. (2) Annalen 45. 132. Gmelin Kraut 2. 1. 635. Chem. Gaz. 1. 367. (3) Annalen 50. 277. (4) Gmelin-Kraut 2. 1. 635. (5) Gmelin. Watts Trans. 2. 457. (6) Annalen 50. 259. Watts Dict. 5. 542. (7) Annalen 50. 273. Gmelin-Kraut 2. 1. 284. (8) Pogg. Ann. 67. 248. Watts Dict. 5. 543. (9) Pogg. Ann. 133. 239. Jahresb. 21. 197. Gmelin-Kraut 2. 1. 284.

†(1) Annalen 50. 286. (2) Pogg. Ann. 67. 256. Gmelin-Kraut 3. 67. Watts

Calcium Sulphite. $CaSO_3 \cdot 2H_2O$.

Calcium sulphite, when heated, gives off water, sulphurous oxide, and sulphur, and leaves a residue consisting of the sulphide and sulphate of calcium, J. S. Muspratt (3); but when subjected to a dull red heat with the exclusion of the air, it leaves behind without forming any volatile products, a mixture of the sulphide and sulphate of calcium, C. Rammelsberg (4), Forester (5).

When the anhydrous sulphate of calcium is heated above redness, sulphurous anhydride is evolved and a mixture of the sulphide, sulphate and sulphite is left, Fr. Schott (6).

Chromium Sulphite.

Chromium sulphite gives off a large amount of sulphurous anhydride when heated, J. S. Muspratt (1).*

Cuprous Sulphite. $Cu_2SO_3 \cdot H_2O$.

Cuprous sulphite is decomposed when it is heated in a crucible, sulphurous anhydride and sulphur being evolved and a residue of cupric sulphate and sulphide left behind, J. S. Muspratt (2). For basic cupric sulphite see (3).

Ferrous Sulphite.

Ferrous sulphite when heated in the air gives off water first, and then at a temperature of about 250° sulphurous anhydride, leaving a residue consisting of a mixture of ferric, and a variable amount of ferrous oxide, Dr. Koene (4).

Lead Sulphite. $PbSO_3$.

Sulphite of lead gives off sulphurous anhydride in the heat, and leaves a mixture of the sulphate and sulphide of lead (5), together with some lead oxide, $5PbSO_3 = SO_2 + 3PbSO_4 + PbS + PbO$, J. S. Muspratt (6).

Magnesium Sulphite. $MgSO_3 \cdot 6H_2O$.

Magnesium sulphite loses some water of crystallization at 100°,

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Dict. 5. 543. (3) Annalen 50. 274. Watts Dict. 5. 543. (4) Pogg. Ann. 67. 249. (5) Pogg. Ann. 133. 106. Jahresb 21. 197. Gmelin-Kraut 2. 1. 382. (6) Dingl. 202. 52. Tech. Jahr. 1871. 504. Gmelin-Kraut 2. 1. 382.

*(1) Annalen 50. 289. Watts Dict. 5. 543. (2) Annalen 50. 284. (3) Pogg. Ann. 67. 399. (4) Pogg. Ann. 63. 444. (5) Gmelin-Kraut 3. 234. Watts Dict. 5. 546. Miller 639. (6) Annalen 50. 284.

but the whole is not expelled until the temperature of 200° is reached, at which point it decomposes with a loss of sulphurous anhydride, C, Rammelsberg (1),* while at a more elevated temperature the salt loses sulphur, air being excluded, swells up, becomes yellow, then brown, and on cooling settles together in the form of a white mass, consisting of the oxide and sulphate of magnesium, C. Rammelsberg (2), $4MgSO_3 = SO_2 + S + 2MgO + 2MgSO_4$, J. S. Muspratt (3).

Manganous Sulphite. $MnSO_3 \cdot 2H_2O$.

Manganous sulphite loses its water at 100°, and when strongly heated in the air evolves sulphurous anhydride and leaves a dark brown residue, consisting for the most part of manganic oxide, J. S. Muspratt (4); but when it is heated in a retort, it gives off water and sulphurous oxide, grows darker in color and if the temperature be raised to redness, it leaves a greenish-brown pulverulent residue of manganic oxide, manganous sulphate and sulphide of manganese, C. Rammelsberg (5).

Mercurous Sulphite. $2Hg_2O \cdot 3SO_2$.

Mercurous sulphite, when heated in a close tube, melts to a reddish-brown liquid, evolves sulphurous anhydride and yields a sulphinate of metallic mercury and mercuric sulphate, C. Rammelsberg (1).†

Nickelous Sulphite. $NiSO_3 \cdot 4H_2O$ *or* $6H_2O$.

Nickelous sulphite, when heated in a small retort, melts with the separation of water, becomes darker and compact, gives off sulphurous anhydride, and leaves a gray-green residue of sulphate, oxide and sulphide of nickel, the latter being in excess, C. Rammelsberg (2); but when put into a crucible and heated, it leaves a voluminous residue, which consists for the most part of nickelous oxide, J. S. Muspratt (3), amounting to 30.48 per cent., Fordos and Gelis (4).

Potassium Sulphite. $K_2SO_3 \cdot 2H_2O$.

Potassium sulphite, when heated, swells up, and at an elevated temperature gives off sulphurous anhydride, and leaves a residue, consisting mostly of the sulphate of potassium, which is mixed with

*(1) Pogg. Ann. 67. 250. Watts Dict. 5. 546. (2) Pogg. Ann. 67. 250. (3) Annalen 50. 275. (4) Annalen 50. 280. Gmelin-Kraut 2. 2. 483. (5) Pogg. Ann. 67. 256. Gmelin-Kraut 2. 2. 483. Watts Dict. 5. 547.

†(1) Pogg. Ann. 67. 405. Gmelin-Kraut 3. 760. Watts. Dict. 5. 547. (2) Pogg. Ann. 67. 391. Gmelin-Kraut. 3. 547. (3) Annalen 50. 281. (4) J. Ph.

some sulphide and probably some free alkali, $5K_2SO_3 = SO_2 + 3K_2SO_4 + K_2S + K_2O$, J. S. Muspratt (5).

Silver Sulphite. Ag_2SO_3.

Silver sulphite, when heated to 100°, decomposes into metallic silver and sulphate of silver, Berthier (1) ;* but when heated in a crucible to an incipient redness, it evolves sulphurous anhydride and leaves metallic silver together with some sulphate, which at a strong red heat decomposes into metallic silver, oxygen and sulphuric acid, J. S. Muspratt (2).

Sodium Sulphite. $Na_2SO_3 \cdot 7H_2O$.

Sodium sulphite melts at 113° (3), and at or under 150° it gives off the whole of its water, becoming white and enamel-like, and at a higher temperature it melts to yellowish-red mass, consisting of 1 p't of the sulphide and 3 p'ts of the sulphate of sodium, C. Rammelsberg (4), Vanquelin (5). When the salt is heated it melts in its water of crystallization under strong inflation, and at a higher temperature loses its water and a portion of its acid, J. S. Muspratt (6).

Strontium Sulphite. $SrSO_3$.

Strontium sulphite, when heated, evolves sulphurous anhydride and sulphur, J. S. Muspratt (7) ; but when subjected to a red heat with exclusion of the air, it leaves a mixture of the sulphide and sulphate of strontium, $4SrSO_3 = SrS + 3SrSO_4$, A. Forester (8).

Zinc Sulphite. $ZnSO_3 \cdot 2H_2O$.

Zinc sulphite, when heated in a glass tube, decomposes above 200°, evolving sulphurous anhydride and leaving behind zinc oxide, Dr. Koene (9) ; but when heated in a closed vessel, it gives off water and sulphurous anhydride, and leaves behind a yellowish-white residue, which consists of the sulphide, sulphate and oxide of zinc, C. Rammelsberg (10), J. S. Muspratt (11).

Chim. [3] 4. 333. Gmelin-Kraut 3. 547. (5) Annalen 50. 261. Gmelin-Kraut 2. 1. 41. Watts Dict. 5. 549.

*(1) Ann. Chim. Phys. [3] 7. 82. Gmelin-Kraut 3. 925. Ros. and Sch. 2. 1. 376. (2) Annalen 50. 286. Gmelin-Kraut 3. 925. (3) Miller 361. (4)Pogg. Ann. 67. 247. Gmelin-Kraut 2. 1. 180. Watts Dict. 5. 549. (5) Ann. Chim. 24. 264. Crell. Ann. 2. (1800) 405. (6) Annalen 50. 268. (7) Annalen 50. 274. Gmelin-Kraut 2. 1. 329. (8) Pogg. Ann. 133. 106. Jahresb. 21. 197. Gmelin-Kraut 2. 1. 329. (9) Pogg. Ann. 63. 435. (10) Pogg. Ann. 67. 253. Gmelin-Kraut 3. 21. (11) Annalen 50. 283. Watts Dict. 5. 550.

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Trommsdorff. Mercuric phosphate.
Troost and Deville, see Deville and Troost.
Van Der Zoon. Zinc sulphate.
Vanquelin. Sodium sulphite.
Vanquelin and Foucroy, see Foucroy and Vanquelin.
Vincent. Arsenious sulphide.
Vogel. Antimonic sulphide. Cupric chloride. Stannous chloride.
Vogel and Reischauer. Zinc nitrate.
Wanklyn and Carius, see Carius and Wanklyn.
Warington. Mercuric iodide.
Weber. Aluminium bromide. Aluminium chloride. Aluminium iodide.
Wernicke. Silver iodide.
Werther. Barium iodide.
Williams and Carnelley, see Carnelley and Williams.
Wöhler. Aluminium chloride. Chromium bromide. Chromium chloride
Wöhler and Bauch. Chromium bromide.
Wright and Menke. Manganous chloride:
Yvon. Mercurous iodide.

THE END.

THE ATOMATION OF OXYGEN.

By Albert R. Leeds, Ph. D.

FIRST MEMOIR.

The readers of this journal will have noted that ever since the publication of my earliest paper, bearing upon the subject of the Atomation of Oxygen, and entitled "Upon Ammonium Nitrite and upon the By-products obtained in the Ozonation of Air by Moist Phosphorus," Vol. I., p. 145, I have taken the ground that the essential feature in oxidation-processes was the splitting of the oxygen molecule, and the setting free of atomic oxygen, or oxygen in the state of free atoms (sometimes called active or nascent oxygen). I have preferred to employ the term atomic, and the phrase atomation of oxygen, rather than the terms *active* or *nascent*, because ozone is eminently active oxygen, while at the same time it consists of atoms in a combined condition.

The experimental proof of the proposition, that the oxygen must be brought into the atomic condition before it can re-combine to form ozone, hydrogen peroxide, ammonium nitrite, carbon dioxide, etc., is so fully given in the recent paper, "Conversion of Carbon Monoxide into Carbon Dioxide by Active (i.e., Nascent) Oxygen," that it is needless to rehearse it.

My present object is to present two hypotheses differing from the foregoing, the first by Hoppe-Seyler, the second by M. Traube, an animated controversy concerning which has been carried on for many months.

The first publication by Hoppe-Seyler in the Berlin Berichte upon this topic was in 1879, Vol. XII., p. 1551, "Upon the excitement of oxygen by nascent hydrogen." He begins by stating that every investigation undertaken with the object of explaining the life-processes in animals and plants, necessitates the assumption of some adequate source of the activation of oxygen within the organism: He deduces conclusions upon this point from certain phenomena attendant upon putrefaction, and states that the formation

of free hydrogen occurs under these conditions only when oxygen is absent. On the other hand, when oxygen is admitted to putrefying liquids, the nascent oxygen is not only oxidized, but energetic processes of oxidation are set up. The simplest explanation of these facts, according to Hoppe-Seyler, is the assumption that the nascent hydrogen, whilst it itself enters into combination with oxygen, at the same time brings to pass the activation of one or more atoms of oxygen. To test the validity of this hypothesis, Seyler proposes the use of hydrogenized palladium. "From Graham's experiments," he says, "it is known that palladium at ordinary temperatures takes up no oxygen, and one can readily satisfy himself that the ignited foil when placed in a confined volume of oxygen does not change. The oxygen, therefore, is not made active by the metal, whilst foil saturated with hydrogen and brought into oxygen, not only quickly forms water, but likewise is in a condition adequate to bring to pass the most energetic processes of oxidation." As proof, he instances the oxidation of indigo by these means, the decomposition of potassium iodide, the conversion of ammonia into ammonium nitrite, and the production of phenol from benzol.

Further on, he describes the products of oxidation of petroleum-ether by sodium in contact with moist air, but does not decide whether these oxidation-processes are due to oxygen rendered atomic by direct action of the sodium, or by the hydrogen first set free and afterwards decomposing the oxygen molecule.

In this publication no mention is made of the formation of hydrogen peroxide, nor is the antecedent probability of its formation on hypothetical grounds alluded to.

On meeting with this research of Hoppe-Seyler, it appeared to me that there was no reason why the atomation of oxygen by palladium-hydrogen should not be in obedience to the same law, as its atomation by phosphorus. Nor any reason why the same secondary products should not be necessarily formed, as resultants of the recombination of this atomic oxygen with itself or with oxygen to form ozone, with water to form hydrogen peroxide, and with nitrogen and the elements of water to form ammonium nitrite and nitrate. The probability was rendered stronger, because I had performed the experiment, before encountering these results detailed by Hoppe-Seyler, of submitting benzol to oxygen in presence of moist phosphorus, and found that, under these circumstances, the benzol was converted into phenol.

On trying the experiment with hydrogenized palladium in pres-

ence of air and water, the formation of hydrogen peroxide was demonstrated (Ber. Bericht. XIV., 976). Furthermore, since the formation of phenol from benzol could not be accounted for by direct oxidation with atomic oxygen, and since I had shown that ozone decomposes benzol entirely into oxalic, formic and acetic acids, together with a small amount of some black, amorphous substance (ib. p. 975), the formation of phenol in Hoppe-Seyler's experiments could be explained only on the supposition of the intermediate production of hydrogen peroxide. This supposition proved correct, and an experiment in which benzol was heated directly with hydrogen peroxide, yielded phenol according to the equation :—

$$C_6 H_6 + H_2 O_2 = C_6 H_5 OH + H_2O.$$

Of the two other by-products (ozone and ammonium nitrite) I looked for the former only, because I was satisfied with the demonstration of the production of ammonium nitrite given by Hoppe-Seyler (loc. cit.) This last point, however, has been emphatically denied by Traube (Ber. Bericht. XVI., 1206) on the strength of obtaining a negative result, thereby inciting Hoppe-Seyler to bring forward the following experiments (Ib. 1923.)

"All the glass apparatus and caoutchouc tubing, just previous to the beginning of the experiment, together with the hydrogenized palladium, were cleansed with water, which had been distilled with pure sulphuric acid and afterwards with a little pure soda. From the glass vessel, in which was the wet foil (91 square centimetres in area and 13.2 grm. in weight), the air went through a wash-bottle with some pure water, then through caustic soda, and finally through sulphuric acid. The foil was allowed to remain for three days in the vessel, and a small fresh portion of air was drawn through the apparatus very two or three hours. At the close of the experiment the foil and the interior of the vessel were washed out with a couple of cubic centimetres of pure water, two or three drops of pure caustic soda added and the mixture evaporated with boiling to a small volume. After cooling, it was acidulated with pure sulphuric acid, and tested with (1) potassium iodide starch paste ; (2) with sulphanilic acid and naphthylamine sulphate ; (3) with metadiamidobenzole ; (4) with sulphindigotic acid ; (5) with ferrous sulphate and sulphuric acid. In like manner, the water in the wash-bottles through which the air after passing from the glass vessel was drawn, was tested." In both liquids, the sulphindigotic acid

and the ferrous sulphate with sulphuric acid did not give reactions, the other three test-liquids did.

I have been thus particular to quote these elaborate experiments, because the establishment of the fact of the production of nitrous acid under the conditions studied, is of so great theoretical importance, and because the cumulative evidence of the certainty of this fact, can best be appreciated by a critical examination of the above detailed account of Hoppe-Seyler's labors.

The discovery of the formation of hydrogen peroxide has not only been admitted on all hands, but apparently has three claimants. For whilst Traube brought it forward as a new observation of his own (Ber. Bericht. XVI. 222), and placed great stress upon it in support of his hypothesis, later on he calls attention to his mistake, and credits me with the observation (*ib.* 2429). In the same way, he states that Hoppe-Seyler had overlooked the production of hydrogen peroxide in his article upon the activation of oxygen, written in 1879 (Ber. Bericht. XII. 1551). But Baumann states (Ber. Bericht. XVI., 2149) that Hoppe-Seyler first noted the phenomenon (Zeitschr f. physiol. Chem. II., 25), and that, therefore, when he himself observed it in the contact of hydrogenized palladium with water and air, he regarded it as no new thing. (Zeitschrift, f. physiol. Chem., V., 248). Not having access to the Zeitschrift referred to, I am unable to form an opinion as to whether Traube or Baumann is right in this particular. [See Appendix to this article.]

The third body, the ozone, which, according to my interpretation of these phenomena, is always to be looked for, was sought in my own experiment in the atmosphere in the bottle over the hydrogenized palladium. But although only a negative result was obtained, as, in fact, I anticipated, in view of the very small amount of oxidation possible by a small piece of hydrogenized palladium (Bericht. XIV., 978), yet I see no more *a priori* reason militating against the probability of the formation of ozone by the hydrogenized palladium, than for the production of hydrogen peroxide or ammonium nitrite.

Subsequent to the work above alluded to, a long series of articles upon the "Activation of Oxygen" has been published by M. Traube. In the earliest of these (Ber. Bericht. XV., 222), Traube lays down the following propositions :

I.—"Palladium-hydrogen gives, when shaken with water and air, immediately and in large quantity hydrogen peroxide. The forma-

tion of hydrogen peroxide under these circumstances has been hitherto overlooked."

It has been already mentioned that Traube himself corrects the latter part of the statement, and credits me with having first noted the reaction. I do not know where Traube has shown by quantitative determination that hydrogen peroxide is formed in notable amount. In one of my own experiments with a piece of hydrogen palladium weighing 10 grammes, 0.67 mgrm. of hydrogen peroxide was obtained. Hoppe-Seyler, in a recent publication (Bericht. XVI., p. 1920), obtains a similar result. He states that with palladium, hydrogenized to its maximum, whether the contact with water and air is continued only a few minutes or many hours, the percentage of H_2O_2 does not increase beyond 2 mgrm. in a liter. The highest percentage obtained was 6 mgrm. per liter."

II.—"The oxidations effected by palladium-hydrogen, in presence of air and water, do not proceed from it directly, but entirely from the resultant hydrogen peroxide."

III.—"There is one case only, so far as my present experience goes, in which the oxidation-processes effected by palladium-hydrogen, in presence of air and water, are different from those of hydrogen peroxide. Whilst the last does not turn potassium-iodide-starch blue, rapid bluing occurs by palladium-hydrogen and oxygen. This action is due to the palladium playing the part of a carrier of oxygen from the hydrogen peroxide to the potassium iodide."

IV. "In opposition to the view of Hoppe-Seyler, my investigations have shown that nascent hydrogen is not able to activate oxygen by splitting of its molecule."

V. "The frequent production of H_2O_2 by oxidation-processes, is not proof of the contemporaneous presence of active oxygen, since this H_2O_2, as I have show by direct experiments and contrary to former assumption, never arises by oxidation of water by means of active oxygen. In these oxidation-processes it is formed by a mode of reduction."

These four last propositions, have provoked a controversy, which has run through many numbers of the Berichte, and has become so involved and so voluminous that I fancy but few chemists have found leisure and inclination to follow it.

And yet to chemists in general it should have great interest, because the discussion involves the endeavor to demonstrate, by critical experiments, the nature of those obscure chemical reactions involved in the so-called nascent state, catalysis, oxygen-carrying, etc.

To physiological chemists its interest should be no less. On the one hand, Hoppe-Seyler thinks that he has demonstrated that it is hydrogen which possesses in the nascent state the power of producing in contact with ordinary oxygen, the most energetic oxidations, water at the same time being formed. "These facts, he remarks, are of the greatest importance in physiology, because for the first time it has been shown from the properties of chemical substances that the energetic oxidations stand in well ascertained dependence upon other processes, by which bodies are formed that act upon oxygen in the same way as hydrogen when in the nascent state." Traube, on the other hand, ascribes the activation of oxygen in the organism to oxygen-carriers. By oxygen-carriers he means bodies like platinum, which, according to the explanation of De la Rive, have the property of readily yielding the oxygen which they have taken up to other bodies, and then forthwith as quickly taking up new oxygen again.

I propose to consider these several propositions and present the arguments and experiments which have been brought forward both pro and con. Inasmuch, however, as besides the contradictory results obtained by the contending parties in the performance of the same experiments, there is a different mode of interpreting the significance of these results, there will be no use in weighing the value of the experimental evidence until some mode of interpretation is agreed upon which will be impartially applied in every case.

INTERPRETATION OF RESULTS.

And 1st. It must be agreed I think on all hands, that the existence of atomic oxygen, as a substance distinct from, and antecedent to the production of ozone, is a demonstrated fact. The demonstration consists in the proof that this atomic oxygen will effect oxidations which ozone will not, as in the oxidation of carbon monoxide to dioxide, at common temperatures. And the converse of this proposition is likewise true, which is, that when ordinary oxygen is brought into a condition to effect the oxidation of carbon monoxide to carbon dioxide atomic oxygen must be present, and the substance which is capable by its presence of effecting this oxidation must have the power of splitting the oxygen molecule, that is, of setting free its constituent atoms.

The original experiment upon which the first proposition was founded was that of the oxidation of carbon monoxide in the passage of air over moist phosphorus. Although both ozone and hydro-

gen peroxide are formed in the course of this experiment, yet as neither of these bodies will oxidize the monoxide, the necessity of the existence of atomic oxygen to account for the fact, is admitted. Subsequent to this observation, Baumann noted that palladium-hydrogen had the same property as phosphorus, and that in its presence moist air could raise the monoxide to dioxide (quoted in Ber. Bericht., XVI. 123). This result prompted Traube to ascertain whether or no ignited palladium placed in dilute hydrogen peroxide and agitated in contact with carbon monoxide out of contact with air, would produce carbon dioxide (Bericht, XVI. 126). He obtained an affirmative result, and this result is confirmed by Baumann (*ib.* 2150). But their modes of interpretation are different. Traube reasons that inasmuch as air was absent no atomic oxygen could have been formed, but that the palladium by catalytic action caused the hydrogen peroxide to effect an oxidation which alone it could not have effected.

Whilst admitting and confirming Traube's result, for Baumann agrees with Traube in finding that ignited palladium in contact with H_2O_2 and CO produces much more CO_2 than palladium-hydrogen when agitated with CO and water, Baumann's explanation is different. There appears to have been a tacit admission on his part that the formation of H_2O_2 must occur as an intermediate step when the palladium-hydrogen is agitated in contact with water and CO out of contact with air. Further, that it is possible that this H_2O_2 is then decomposed by the palladium, ozone being formed. (He might have added, atomic oxygen is likewise formed.) And although this formation of ozone by decomposition of H_2O_2 with palladium has not been observed, yet he regards it as eminently probable, inasmuch as when H_2O_2 is decomposed by sulphuric acid (this fact was originally noted by Riche (Bull. Soc. Chem., 1860, 178), ozone is given off. Having repeated this experiment of Riche (J. Amer. Chem. Soc., I., 442), I can confirm his statement, the liberated ozone being so powerful as to blacken silver foil. But Baumann appears to have gone further and to have subjected carbon monoxide to the action of the evolved gas, since he states (without giving the particulars of the experiment) that the carbon monoxide was more powerfully oxidized by this gas than by any of the other methods. This being the case, as Baumann justly observes, the decomposition of the H_2O_2 by sulphuric acid must be attended by the evolution of atomic oxygen as well as ozone.

Furthermore, Baumann tried the experiment of passing moist air

over palladium-hydrogen to see whether the water condensed after its passage contained H_2O_2. The result was negative. But inasmuch as moist air and CO passed over dry palladium-hydrogen had yielded CO_2, Baumann thinks that the negative result might be accounted for on the ground that the atomic oxygen could have produced CO_2 under circumstances, under which the oxidation of water to H_2O_2 was not demonstrable. Since, later on, Baumann says that he agrees with me in the interpretation I have given of these phenomena, I think he would further assent to the following as a more explicit formulation of his own remarks and observations, viz. :—

That inasmuch as carbon monoxide is oxidized under the conditions stated, the palladium must have effected the atomation of the oxygen molecule. The oxygen set free from the H_2O_2, which, when spontaneously liberated will not oxidize CO to CO_2, will bring about this oxidation in the presence of palladium. In other words, the so-called catalytic actions of palladium, platinum, and metals of that group are due to atomation.

Since these metals do not combine with the oxygen under the conditions named, they are in no proper sense *carriers of oxygen.* They do not carry oxygen, but, on the contrary, decompose it, bringing it into the atomic condition, and thus effect their so-called catalytic actions.

EXPERIMENTAL PROOFS.

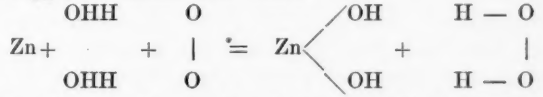
In his first paper (Bericht. XV., 664) Traube brought forward the deportment of zinc when shaken in contact with water and air, both in neutral and acid solution, in support of his hypothesis ; also that of copper in presence of sulphuric acid.

But in the mode of statement, the actual conduct of the experiments and the inductions based thereon, these proofs are of the most inconclusive character.

Traube begins by stating that in case the oxidation of zinc, by shaking with air and water, produces atomic oxygen, then an oxidizable body present at the same time must be rapidly oxidized. But he finds that whether pure zinc or very dilute sulphuric acid is employed, such oxidation is not produced, although in both cases abundance of H_2O_2 is formed.

Traube places great emphasis on the fact that pure zinc out of contact with air does not decompose water and set free its hydrogen. Therefore, that what the affinity of the zinc alone for the oxygen of the water will not effect, this affinity, aided by the affinity of a whole molecule of atmospheric oxygen, will succeed in

doing ; that is, the two together will split up the molecule of water. The supposed reaction is as follows :—



According to Bonsdorff and Boutigny (Gmelin–Kraut, 3d vol., 1st part, p. 5), when zinc is inclosed in glass tubes with water from which the air has been expelled by boiling, it remains unaffected for years. According to J. Davy (ibid.) it does not decompose pure water even on boiling, and even in contact with copper it does not appreciably decompose pure water.

In repeating these experiments I have obtained different results. The purest zinc which I could procure contained lead, iron and carbon in minute amounts, and consequently the deportment of absolutely pure zinc with pure water is not determined by my own trial. Forty grammes of this zinc in extremely thin fine turnings were introduced into the upper portion of a eudiometer tube completely filled with redistilled water free from ammonia. The tube was surrounded by a water bath and maintained at a temperature of 70° for seven hours, during the whole of which time it was connected with an air-pump and a vacuum maintained. The open end of the eudiometer was then plunged into a vessel filled with mercury, and the apparatus allowed to stand from the middle of June to the middle of September. Between the upper surface of the mercury and the zinc in the eudiometer there intervened a space of 8 centimeters filled with water, so that contact between the two metals could not occur. During the whole of this long interval bubbles of gas came off slowly, and finally amounted to a volume of 15.95 cubic centimeters, reduced to 0° and 760 m.m. After the introduction of a suitable excess of oxygen and explosion by the electric spark, a reduction of the measurements showed that the 15.95 cubic centimeters of gas collected during the course of three months consisted of hydrogen. The zinc was very faintly tarnished, appearing somewhat less bright, and of a slightly different color from fresh surfaces of other portions of the same zinc, but no oxide was visible.

Now, it is a well-known fact that zinc, especially when in fine powder, may be employed to bleach a solution of indigo. In this case the indigo blue ($C_{16}H_{10}N_2O_2$) is converted into reduced or white indigo ($C_{16}H_{12}N_2O_2$) by the fixation of nascent hydrogen.

Two interpretations of this phenomenon are possible :—1st.

That the hydrogen liberated from water by ordinary zinc in the manner above described, small in amount though it may be, is adequate in amount, when a large surface of zinc dust is employed, to reduce the indigo. 2d. That soluble indigo or sulphindigotic acid, being acid in its reaction, liberates the nascent hydrogen on contact with zinc, which brings about its reduction. The latter is the correct explanation. For when sulphindylate of potash is employed, the salt being made as nearly neutral as possible, it is found that zinc does not act as a reducing agent, but as a powerful oxidizing agent. Under these circumstances, the blue solution is bleached, it is true, but not by the reduction of the indigo, since the solution retains a yellow tint in contact with the air, and contains no white indigo, the indigo having undergone oxidation. When large amounts of indigo carmine are employed this complete oxidation and decoloration are somewhat difficult to obtain, because of the energy with which fine shavings of zinc are themselves oxidized and the great amounts of zinc hydrate which are formed. On shaking up a liter bottle containing a hundred grms. of zinc in fine shavings, with 100 cc. of indigo carmine solution, the contents of the flask become at once bluish-gray from admixture of suspended zinc hydrate. In this first bottle, which now contains oxidized zinc, complete decoloration is hard to effect, but on filtering off the solution into a bottle containing fresh zinc, bleaching occurs immediately.

My own observations, therefore, are directly opposed to those of Traube, who stated that zinc would not bleach solution of indigo. Moreover, inasmuch as the indigo in my experiments was oxidized and not reduced, they show that zinc shaken up in contact with water and air brings about phenomena of energetic oxidation.

In the second place, hydrogen peroxide is formed under the same conditions. As stated by Traube, the reaction for the peroxide entirely disappears in case the water, after brisk agitation with the zinc, is allowed to remain in contact with it. And inasmuch as the reaction with potassium iodide or with potassium iodide and ferrous sulphate is affected by substances other than H_2O_2, the author did not rely upon these tests in proving qualitatively the presence of the latter body. Instead of so doing freshly-prepared cold malt extract was used. Upon this was floated freshly-made tincture of guaiacum, and it was noted whether any blue color was developed along the surface of contact of the two liquids. If not, the water decanted from the surface of the zinc was poured down the

side of the test-tubes, so as to flow under the guaiacum tincture and above the malt extract. Only when these precautions were observed was the development of a blue color regarded as a satisfactory indication of the formation of hydrogen peroxide.

The oxidation of indigo by zinc in neutral solution would lead us to anticipate the decomposition of potassium iodide under the same circumstances. This anticipation is verified by experiment in case starch is added to the potassium iodide and the mixture then shaken up with the zinc. Under these circumstances iodide of starch is formed, whilst it is not formed in case potassium iodide solution alone is agitated with zinc, the liquid poured off, and then starch added.

Nitrous Acid.—When redistilled ammonia-free water, which failed to give any coloration with sulphanilic acid, was agitated with zinc, the decanted liquid gave a decided reaction for nitrous acid. But when ordinary distilled water, which itself gave a faint coloration with sulphanilic acid, was shaken with zinc, the decanted liquid gave no reaction for nitrous acid, and remained entirely colorless. These reactions were explained by those occurring when a solu- of potassium nitrite, standardized for purposes of water analysis, was treated with hydrogen peroxide. After forty-eight hours it failed any longer to give the nitrous reaction, the acid present having undergone oxidation to nitrate.

To summarize the results detailed above, it may be stated that there is the same evidence of the production of atomic oxygen, when zinc is agitated in contact with water and air, as there is of the production of atomic oxygen when moist air is passed over phosphorus. Moreover, that this atomic oxygen arises from the splitting of the oxygen molecule by the zinc directly, and not by means of hydrogen resulting from any intermediate process. In other words, zinc reduces the oxygen, being rapidly converted in presence of water into hydrate, and setting atomic oxygen free, the equations being

$$Zn + H_2O + O_2 = Zn H_2 O_2 + O.$$

It is this atomic oxygen, which the author supposes to be the efficient agent in the subsequent formation of hydrogen peroxide and nitrous acid, and the origin of the energetic oxidation of the neutral indigo solution and of the decomposition of the potassium iodide in presence of starch.

[*To be continued.*]

Appendix.

The principal portion of this First Memoir was read at the June meeting of the Society, but its publication was delayed by the pressure of other duties subsequently devolving on the author.

Since the article was written I have had the pleasure of receiving letters both from Prof. Hoppe-Seyler and from Prof. Baumann, the former dated November 17, 1883, and the latter, December 10th. Prof. Hoppe-Seyler has likewise kindly sent me reprints of his papers in the Zeitsch. für Physiol. Chemie, bearing upon the matter referred to, and these, together with an extract from his letter, which I shall take the liberty of quoting, will best illustrate the history of the subject. Prof. Hoppe-Seyler says, * * * * "Both of us nearly at the same time and quite independently of one another, have investigated the properties of active oxygen, and in general with the same results. But it would appear from a passage in your memoir, 'The conversion of carbon monoxide into carbon dioxide by active (*i. e.* nascent) oxygen,' that my earlier publications have remained unknown to me. You there remark, 'According to these views the oxidizing effect of palladium hydrogen, as noted by Hoppe-Seyler at a late period in the history of these researches,' etc.

"My earliest observations upon the activating agency of hydrogen when in stat. nasc. were published as far back as 1876, and in 1877 were further elucidated in my Handb. der physiol. Chemie. The powerfully oxidizing action of H in stat. nasc. in the presence of oxygen when palladium-hydrogen is employed, I had already intimated in a preliminary note dated February 21, 1878, and shortly after this it was fully described in the spring of 1878 in Zeits. für physiol. Chemie, Bd. II., p. 22. Some further observations caused me to publish a short summary of the results so far obtained, in the Berichte. The formation of H_2O_2 in certain reactions I had already noted in the beginning of my investigations. but the oxidations which are effected by the agency of H in stat, nasc. are more energetic than those produced by H_2O_2."

The statement alluded to by Prof. Hoppe-Seyler (Zeitsch. für physiol. Chemie, Bd. II., p. 22) is as follows: "By far the most interesting reduction which active hydrogen is capable of effecting, is that of free indifferent oxygen, attended with the formation of water, whether it results in this case that hereby ——— OH or a combination HO-O——— or H_2O + —O— is formed. This is the

origin of powerful oxidations, which indifferent oxygen is not capable of effecting."

Pages 24 and 25, of the same article contains the statement alluded to by Baumann, as showing that I was anticipated by Hoppe-Seyler, in stating that H_2O_2 is a product consequent upon the formation of atomic oxygen in presence of water. It is as follows :—

"Like the liberated hydrogen atom, so also the O-atom cannot remain free, but in case no other oxidizable substances are present it forms with water or indifferent oxygen, either H_2O_2 or O_3."

"The occurrence of nitrous acid in the combustion of hydrogen with air has given occasion to Bunsen (Gasometr. Meth. 1857, p. 65) to set forth appropriate precautions in gas analysis. Recently Zöller and Grete (Ber. deutsch. Chem. Gesell. X, 2144), have recognized the occurrence of small but clearly distinguishable quantities of NH_4NO_2 in the combustion of pure hydrogen gas in pure atmospheric air."

"The action of hydrogen upon indifferent oxygen is the same therefore as the action of many other substances, which possess a very strong affinity to oxygen, such strongly reducing substances, for example, as phosphorus and magnesium."

"It has been lately found by Kämmerer (Berichte X, 1684) that in the combustion of magnesium in air, nitrous acid is formed. In the slow combustion of P at least one atom of oxygen becomes active for every molecule P_2".

$$P_2 + 3H_2O + 2O_2 = 2\,(PO_3\,H_3) + O$$

"The discovery of Schönbein that powdered zinc and iron, when shaken up with air and water, give rise to the formation of H_2O_2 can likewise be explained in hardly any other manner than as a result of a reduction of the indifferent oxygen."

"None of these processes, however, shows simply and clearly like the decomposition of palladium-hydrogen does, the reduction and oxidation effected by means of such decomposition."

I am very glad to yield to Prof. Hoppe-Seyler the merit of having investigated the phenomena consequent upon the evolution of atomic oxygen in a large number of cases, and more especially in that arising from the contact of palladium-hydrogen in contact with air and water. And the difference between his labors and my own appears to consist in the fact that whilst Hoppe-Seyler was engaged upon the demonstration of the formation of atomic

oxygen itself as the main topic of inquiry, I was more intent upon establishing the thesis that whensoever atomic oxygen is produced in the presence of air and water, ozone, hydrogen peroxide and ammonium nitrite are necessarily and simultaneously formed as secondary products. This hypothesis led me to anticipate, in entire ignorance of Hoppe-Seyler's labors, the formation of H_2O_2 when palladium-hydrogen is agitated in contact with water and air, to establish the fact of its formation by experimental proof, and to determine quantitatively its amount. I think it not invidious, nor an undue detraction from the merits of Hoppe-Seyler's discoveries, to claim for myself priority in the two latter points.

STEVENS INSTITUTE OF TECHNOLOGY,

December 15, 1883.

ON A NEW OVERFLOW PIPETTE.

GEO. S. EYSTER, PH.D.

The well known Overflow Pipettes of Gay-Lussac and Stas, whilst adapted for the accurate measurement and delicacy of a given volume of a solution, are not so fit for the use of corrosive fluids, and are not easily extemporized from materials commonly found in a laboratory.

The following pipette is especially adapted for use in alkalimetry, and for the employment of such corrosive solutions as are used in the "copper" method of estimating sugar (Fehling's, &c.)

An ordinary pipette, graduated to deliver a definite volume, is clamped in a *reverse* position; that is with the mark *down*, and the jet *up*. A short piece of rubber tube connects the end that is now the lowest end with one arm of a glass T tube, the other arm of which is provided with the usual Mohr burette tip; or with a glass bead cock.

This glass bead cock is simply a short piece of glass rod, somewhat larger than the bore of the rubber tube, fused into a bead. This bead inserted into the rubber tube effectually stops the flow. When it is desired to open the cock, a slight pinch of the tube over the place where the bead is concealed, will open a channel for the passage of the solution. The flow can be regulated with the greatest nicety. This piece of apparatus is *old*, but does not seem to be as generally known as it should be.

To the lateral arm is attached the rubber tube and pinch cock which supplies the pipette with the solution from the reservoir. The reservoir is either a common bottle, provided with a syphon, or an aspirator bottle. The higher the level of the reservoir above the tip of the pipette, the quicker the pipette will be filled.

In place of the glass cups used in the Stas pipette, I make use of the following arrangement to catch the overflow from the open end.

A large test tube is fitted with a cork with two holes. Through one the jet of the pipette is passed. One arm of a rather wide bent glass tube is inserted in the other hole. This is the drip tube, and is provided with a rubber tube to carry away the excess of solution.

It is easy to see the mode of action. When the pinch cock leading to the reservoir is opened, the solution enters and fills the pipette; the air escapes through the drip tube. When the solution is to be delivered, the lower cock is opened, and the fluid run out until the mark is reached; the air meanwhile enters by the drip tube, and for this reason care must be taken to have the drip tube as wide as possible, and not to allow the rubber drainage tube to dip beneath the fluid in the vessel it connects with.

The error due to reading the meniscus in a reverse position is easily corrected, and in many cases will be eliminated in standardizing the solutions.

I give the simplest form, and one readily made from easily available materials.

If one is somewhat expert in glass blowing, the end of the large test tube (or the wide tube used instead) can be drawn out and bent, so that its extremity can be left open for the admission of air. There is some advantage in this in case the volume of the pipette is large, but it is not necessary in every case.

ON THE ACTION OF COLD, CONCENTRATED SULPHURIC ACID, ON LEAD AND ITS ALLOYS.

By Lucius Pitkin.

Until quite recently it has been regarded as almost indisputable that the purer the lead, the less action would sulphuric acid have upon it. In opposition to this idea, a very interesting paper was

presented by Mr. James Napier, before the Glasgow Philosophical Society, a full report of which can be found in the *Chemical News* for December, 1880.

Briefly abstracted it is as follows: Sulphuric acid was shipped in cases of sheet lead, all of which either bulged badly or burst. To ascertain the cause of this action, the acid, the lead, and the gas causing the pressure were analyzed.

The acid was of Sp. Gr. 1,842 and the following composition, H_2SO_4 99.78—SO_2 0.02—Pb SO_4 0.13—Ca SO_4 0.07.

The lead was of extraordinary purity, containing according to the analysis Pb 99.96—Cu. 0.04. The gas evolved was pure hydrogen.

Exposing a known surface of the lead to the action of cold concentrated sulphuric acid, gas was given off equivalent to 41 cubic inches per square foot lead exposed.

Another sample from a concentrating pan, (No. 1) of the same composition gave under similar circumstances, 16 cubic inches per square foot. A second sample of lead (No. 2) having a composition of Pb. 99.50 Cu. 0.08. Sb. 0.42 yielded only $\frac{1}{8}$ cubic inches per square foot.

As a basis for further experiments, Mr. Napier took a soft lead not analyzed, similar to No. 1, which averaging several determinations yielded 9.4 cubic inches per square foot. Calling this lead No. 3, the following alloys were made and yielded the following amounts of gas by the action of sulphuric acid.

I.	Lead No. 3,	99.25	0.25 cu. inch.
	Sb.		
II.	Lead No. 3,	89.88	0.10 cu. inch.
	Cu.	0.39	
	Sb.	0.75	
III.	Lead No. 3,	99.63	1.42 cu. inch.
	Cu.	0.37	
IV.	Lead No. 3,	99.64	2 cu. inch.
	Zn.	.37	

The paper was discussed by the society, and the President in summing up, said the following points appeared proven:

1. Chemically pure lead was unsuitable for sulphuric acid evaporating pans.

2. Lead containing certain impurities, and especially zinc, was unsuitable.

3. Antimony seemed to render the lead more durable.

4. The subject required further investigation.

It is to this investigation that the remainder of this paper will be devoted.

The lead taken as a basis for the alloys which I have experimented upon, was a chemically pure lead made by Merck, of Darmstadt, and guaranteed by him. The method employed differed from that made use of by Napier, who measured the gas evolved from a known surface of lead.

In the following experiments, the action of the sulphuric acid was measured by the amount of lead or alloy converted into sulphate, which was ascertained by weighing the alloy before immersing in sulphuric acid, and after the action, cleansing from any adhering sulphate and reweighing.

In all forty (40) samples of lead and alloys of known composition were acted upon by the acid and the action measured. In some cases the results may appear anomalous, but not more so than the case reported by Napier, in which lead of the same composition gave off under similar circumstances, in one case 41 cubic inches per square foot, in the other only 16 cubic inches. In the making of the alloys, great care was taken to obtain as homogeneous a mixture as possible, and in order to avoid oxidation, the fusion was performed under a layer of powdered charcoal. The making of 40 alloys was thus by far the most tedious part of the investigation.

The alloys experimented upon were those of lead with antimony, tin, bismuth, cadmium, silver and zinc. After the preparations of the alloys, they were carefully rolled to about the same thickness, and the same surface exposed in each case to the action of the same amount of acid for a like time.

The surface exposed was 2 sq. in., and the amount of acid used 10 c.c. The action was allowed to proceed 24 hours at a temperature of 20° C.

The acid employed was C. P. sulphuric acid of Sp. Gr. 1,825. In the tables the first column gives composition of alloys ; the second, the loss of lead per sq. foot of surface exposed, the weight being in grammes ; the third, the amount of gas evolved calculated from the quantity of lead converted into the sulphate.

1	C. P. Lead.	1.296 grms.	9 cu. in.
2	"	2.088 "	14.5 "
3	"	2.952 "	20.5 "
4	"	2.232 "	15.5 "

Average loss for pure lead, 2.160 grms. per sq. foot.
Average gas evolved from sq. ft., 15 cu. in.

In all cases quite a vigorous evolution of hydrogen took place at the instant of immersion, while in an hour scarcely any action was perceptible. It will be noticed that the quantity of hydrogen evolved agrees quite closely with the amount given off by lead not in Mr. Napier's experiments.

In the case of the alloys, however, I did not find that the addition of foreign metals produced such a change in the amount of lead converted into sulphate, as the following figures will show.

In computing the amount of gas, the loss is calculated for convenience as entirely lead.

ANTIMONY ALLOYS.

5	Pb.	100	Sb.	0.5	parts	1.872	gms.	13	cu. in.
6	Pb.	100	Sb.	1	"	2.016	"	14	"
7	Pb.	100	Sb.	2	"	2.016	"	14	"
8	Pb.	100	Sb.	3	"	1.512	"	10	"
9	Pb.	100	Sb.	5	"	1.584	"	11	"
10	Pb.	100	Sb.	10	"	1.584	"	11	"

It will be seen from this that under the conditions of the experiment, the antimony did not seem to affect the lead to such a degree as in Mr. Napier's researches, although retarding the action of the acid.

It shows, however, what a large amount of antimony may be present without affecting the solubility of the lead.

TIN ALLOYS.

11	Pb.	100	Sn.	0.5	parts	2.802	gms.	19	cu. in.
12	Pb.	100	Sn.	1	"	3.744	"	26	"
13	Pb.	100	Sn.	2	"	3.080	"	22	"
14	Pb.	100	Sn.	3	"	2.952	"	21	"
15	Pb.	100	Sn.	5	"	3.232	"	23	"
16	Pb.	100	Sn.	10	"	2.380	"	17	"

In the case of the alloys with tin, the action is in all cases augmented, but does not seem to increase in proportion to the amount of tin present.

BISMUTH ALLOYS.

17	Pb.	100	Bi.	0.5	parts	1.800	gms.	12	cu. in.
18	Pb.	100	Bi.	1	"	4.032	"	28	"
19	Pb.	100	Bi.	2	"	1.656	"	11	"
20	Pb.	100	Bi.	3	"	1.728	"	12	"
21	Pb.	100	Bi.	5	"	2.232	"	16	"
22	Pb.	100	Bi.	10	"	3.600	"	25	"

The figures in number 18 are evidently anomalous, and probably were the result of an imperfect admixture or separation of the Bi and Pb. If they are disregarded we would have the general action of bismuth in the alloys with lead as retarding in quantities less than 5 per cent., and above that figure hastening the formation of lead sulphate.

CADMIUM ALLOYS.

23	Pb. 100	Cd.	0.5	parts	1.728	gms.	12	cu. in.
24	Pb. 100	Cd.	1	"	1.656	"	11	"
25	Pb. 100	Cd.	2	"	1.296	"	9	"
26	Pb. 100	Cd.	3	"	1.728	"	12	"
27	Pb. 100	Cd.	5	"	1.296	"	9	"
28	Pb. 100	Cd.	10	"	3.528	"	24	"

In regard to cadmium we have it decreasing the solubility of lead to a greater extent even than antimony, while above 5 per cent. it raises its solubility.

SILVER ALLOYS.

29	Pb. 100	Ag.	0.5	parts	1.584	gms.	11	cu. in.
30	Pb. 100	Ag.	1	"	1.728	"	12	"
31	Pb. 100	Ag.	2	"	1.944	"	13	"
32	Pb. 100	Ag.	3	"	1.584	"	11	"
33	Pb. 100	Ag.	5	"	2.016	"	14	"
34	Pb. 100	Ag.	10	"	2.448	"	17	"

Silver seems to exert very little influence, in small proportion, slightly decreasing the action, in large proportion slightly increasing the solubility.

ZINC ALLOYS.

35	Pb. 100	Zn	0.5	parts	2.664	gms.	18	cu in.
36	Pb. 100	Zn	1	"	2.304	"	16	"
37	Pb. 100	Zn	2	"	3.816	"	26	"
38	Pb. 100	Zn	3	"	2.664	"	18	"
39	Pb. 100	Zn	5	"	4.032	"	28	"
40	Pb. 100	Zn	10	"	4.392	"	30	"

The solubilities of the alloys of lead and zinc are thus greater than those of lead with any other metal experimented upon. To sum up the results of the work, it appears :

1. The metals, Antimony, Bismuth, Cadmium, and Silver in small quantities, protect lead from the action of the cold sulphuric

acid; while in proportions above 5 per cent., they all, with the exception of antimony, increase the solubility.

2. Antimony when present even to the amount of 10 per cent. decreases the solubility of the lead.

3. Tin and zinc alloys are more affected than pure lead.

ACTION OF CONCENTRATED SULPHURIC ACID, AT 100° C., ON LEAD AND ITS ALLOYS.

By L. Pitkin.

The only work of any importance done, in the estimation of the effect produced upon lead by hot concentrated sulphuric acid, is that of Bauer. The acid used by him was 170° T. (Sp. Gr. 1.848), the amount of lead or alloy taken 0.2 gramme, and the amount of acid used 50 c.c. A brief abstract of his work, so far as it relates to alloys used by me, is here given.

I. *Pure lead.*—The first sensible evolution of gas was at 175° C., a stronger action taking place at 190° C., while at 230°—240° C. all of the lead was suddenly changed to sulphate.

II. *Lead and bismuth alloys.*—

(*a*). Pb. 90 per cent., Bi. 10 per cent.

Action begins at 150° C., continues quietly to 190° C., when all of the metal is decomposed.

(*b*). Pb. 96 per cent., Bi. 4 per cent.

This alloy decomposes more quickly than (*a*), the action terminating at 130°—140° C.

(*c*). Pb. 99.27 per cent., Bi. 0.73 per cent.

Rapid and sudden decomposition at 160° C.

III. *Lead and antimony alloys.*—

(*a*). Pb. 90 per cent., Sb. 10 per cent.

A slow and even decomposition takes place, beginning at 190° C., terminating at 240° C.

(*b*). Pb. 95 per cent., Sb. 5 per cent.

Decomposition begins at 180° C., terminating at 225° C.

(*c*). Pb. 99 per cent. Sb. 1 per cent.

Action begins at 250°, ends at 280° C.

IV. *Lead and tin alloys.*—Sudden decomposition at 200° C.

The alloys used by me in determining the effect of hot acid were

the same as those employed in estimating the action of cold acid, namely, lead with antimony, tin, bismuth, cadmium, silver, and zinc. The amount of acid was as before, 10 c.c. and the surface exposed 2 sq. in., but the time of exposure was 1 hour, instead of 24 hours, as in testing with cold acid. The amount of gas given off per square foot was not calculated, as that factor would be essential only in the employment of lead for cases. The amount of lead or alloy converted into sulphate per square foot is given in grammes.

The four samples of pure lead, exposed to the action of concentrated acid at 100° C. for one hour, gave very concordant results, as follows :

41.	Pure lead	1.368	Grammes.
42.	"	1.152	"
43.	"	1.224	"
44.	"	1.080	"

The effect of antimony in composition with lead is shown in the following experiments :

45.	Pb. 100 parts,	Sb. ½ part	2.952 G.
46.	"	" 1 "	3.672 G.
47.	"	" 2 "	3.528 G.
48.	"	" 3 "	3.096 G.
49.	"	" 5 "	2.736 G.
50.	"	" 10 "	2.952 G.

Upon immersing the alloy, very little gas was given off, and for 40 minutes the acid remained clear. It then commenced to cloud, and the alloy taken out at the end of the hour was covered with black slime. It will be seen that at 100° C. the action of antimony is not that of a preservative of the lead, as is the case with cold acid ; while from the experiments of Bauer, quoted above, it seems quite likely that at elevated temperatures the alloy with antimony may be more resisting than pure lead. The relative solubilities of the alloys at ordinary temperatures and at 100° C. are by no means constant, and this forms one of the most interesting features of the investigation ; thus, if at common temperatures the alloys with antimony, are found more insoluble than those with zinc, we cannot predicate the same relation with acid at 100° C. In regard to the action of tin upon lead, as affecting its solubility, the following results were obtained :

51.	Pb. 100 parts,	Sn. ½ part....	1.008 G.
52.	"	" 1 "	0.792 G.
53.	"	" 2 "	0.864 G.
54.	"	" 3 "	0.792 G.
55.	"	" 5 "	0.864 G.
56.	"	" 10 "	0.864 G.

It will be remembered that one of the general results obtained from the experiments with cold acid was, that at ordinary temperatures the alloys of lead and tin were more easily attacked than those with antimony, or pure lead itself, and yet at this temperature we see the case reversed.

It is, however, in regard to bismuth that the most curious effects were found to be produced by the composition of the alloy. The following figures will fully explain the peculiar action of the bismuth:

57.	Pb. 100 parts, Bi.	½ part.....	24.840 G.
58.	" "	1 "	22.248 G.
59.	" "	2 "	1.800 G.
60.	" "	3 "	1.008 G.
61.	" "	5 "	1.008 G.
62.	" "	10 "	2.160 G.

The results given in 57 and 58 appear so exceptional, not only in comparison with other alloys, but in regard to the sudden change shown in 59 and 60, that it was decided to make Experiments 57, 58 and 60 in duplicate.

57.	(Duplicate) Pb.	100 parts, Bi. ½..	25.920
58.	"	" Bi. 1..	22.750
60.	"	" Bi. 3..	1.224

We here have a case in which not only the relative solubility in hot and cold acid is changed as regards other alloys, but one in which an excess of the deleterious substance seems to act as a corrective.

The alloys containing ½ and 1 part of bismuth to 100 of lead gave off gas very plentifully, not only at the start, but throughout the whole hour, while the acid became opaque almost immediately, and the lead sulphate formed could be removed in scales at the end of the experiment.

The experiments with cadmium alloy gave very constant results,

and in general it may be said that, with the exception of bismuth alloy, the figures obtained from the same alloy varied much less than in the corresponding trials with cold acid.

63.	Pb. 100 parts,	Cd.	½ part.....	1.440 G.
64.	"	"	1 "	1.224 G.
65.	"	"	2 "	1.296 G.
66.	"	"	3 "	1.080 G.
67.	"	"	5 "	1.368 G.
68.	"	"	10 "	1.152 G.

The action of cadmium at this temperature seems to be neither increasing or diminishing the action of the H_2SO_4 on the lead.

In the case of silver combined with the lead, we have the same general behavior, six determinations with varying quantities of silver giving the following results :

69.	Pb. 100 parts,	Ag.	½ part.....	1.296 G.
70.	"	"	1 "	1.080 G.
71.	"	"	2 "	0.864 G.
72.	"	"	3 "	0.792 G.
73.	"	"	5 "	0.936 G.
74.	"	"	10 "	1.440 G.

The action of zinc in determining the solubility of lead in hot acid is in accordance with its effect on cold concentrated acid—that is, increases the effect of the acid, but the action is not so marked as at ordinary temperatures. The figures for the experiments are :

75.	Pb. 100 parts,	Zn.	½ part.....	1.800 G.
76.	"	"	1 "	1.296 G.
77.	"	"	2 "	1.152 G.
78.	"	"	3 "	1.080 G.
79.	"	"	5 "	1.296 G.
80.	"	"	10 "	1.080 G.

We can easily see from the results we have obtained the importance of testing the lead employed in H_2SO_4 working, and for this no extended analysis is required. The operation consists simply in immersing the lead in acid, more or less concentrated according to the strength of the acid with which it will be brought into contact in actual working, and at the temperature to which it will be subjected in the manufacture of acid.

Mr. McTear says : " The simplest safeguard against risk to pans, etc., giving way would be a careful testing of the lead previous to

being made into sheets. For this purpose it will not be necessary to make an analysis, but simply to put clean, thin shavings of lead into a test-tube and cover with pure, cold vitriol, the amount of action would then be clearly visible."

It is, however, clear that the action of cold acid is no sure criterion of the effect that hot acid will have upon the lead; so, to avoid error, it is much safer to test the lead under the conditions of its actual employment.

In order to briefly sum up the results of experiment, it will be advantageous to compare the average of the alloys with pure lead as unity both at ordinary temperatures and at 100° C. The following table will therefore express the average solubility or liability to formation of sulphate of the alloys in terms of lead. In each case the total of the relative solubilities is divided by six (the number of members in the class), for the average solubility of the alloys:

	20° C.	100° C.
Pure lead	1.00	1.00
Pb. 100, Sb. 1 to 10 parts	0.81	2.75
Pb. 100, Sn. 1 to 10 "	1.42	0.75
Pb. 100, Bi. 1 to 10 "	1.10	7.69
Pb. 100, Cd. 1 to 10 "	0.86	1.10
Pb. 100, Ag. 1 to 10 "	0.87	0.93
Pb. 100, Zn. 1 to 10 "	1.53	1.10

OBITUARY.

Dr. John Lawrence Smith, died at his home in Louisville, Kentucky, on the 12th of October last, in his 65th year, having been born near Charleston, South Carolina, on the 16th of December, 1818. He had been for some years in rather delicate health and had of late retired very much from the active duties of the laboratory, but maintained his interest in scientific studies.

Dr. Smith pursued his academic studies at the University of Virginia, with which he was later connected as a professor. His medical degree was taken at the Medical College of Charleston. Immediately after this he went to France and Germany, where he zealously followed his medical studies, as also chemistry, physics and mineralogy. While yet a student of medicine at Charleston, he commenced his original work by sending to Silliman's Journal a paper, "On a new method of making permanent magnets by

galvanism." In 1841 he commenced his contributions from Paris in a memoir on the detection of arsenic in the human body, and for the term of his residence abroad he was a regular correspondent of the *American Journal of Science.* The list of his papers in the Royal Society's catalogues embraces seventy-eight titles, down to 1873. In that year Dr. Smith printed in a volume of four hundred pages, 8vo., a collection of the more important of his original researches, embracing forty-seven titles.

Dr. Smith returned to Charleston in 1844 from his first European residence, and commenced his professional work as a physician, which was, however, so little to his taste that he soon abandoned it for the life of an investigator in scientific pursuits. As assayer of the State of South Carolina, he made a study of the soils adapted to the growth of cotton—analyzing, also, the marls used as fertilizers. The Turkish Government soon called him to Constantinople as one of a commission to promote the growth of cotton in Asia Minor. But his active mind developed new lines of investigation and opened up sources of wealth before unknown in the Sultan's dominions, especially in the important discovery of Emery, of which he gives us the first account, setting forth its geology and mineralogy. The Morse telegraph was developed while Dr. Smith was in Turkey, and he wrote immediately to the writer to send him an outfit of telegraphic apparatus which he set up at the Sultan's palace, communicating with the port.

His memoir on the Emery was communicated to the French Academy of Science, and was with distinguished encomiums ordered for publication in the *Memoirs des Savants Etrangers.*" He subsequently extended his researches to the Emery of Chester, Massachusetts.

During his brief occupancy of the Chair of Chemistry, at the University of Virginia, he carried out his elaborate research on American minerals, devising and perfecting his method for the determination of alkalies in the silicate. Professor Johnson, in the American edition of Fresenius, says Professor Smith's method is by far the most convenient and accurate for separating alkalies from a silicate, and is universally applicable, except, perhaps, in presence of boracic acid.

In 1854 Dr. Smith was called to Louisville on the resignation of Professor Silliman of the Chemical Chair in the Medical Department, as his successor, and this chair he held for several years. Here he married Miss Guthrie, who survives him. They had no

children. By their marriage Dr. Smith became possessed of an ample fortune which enabled him to devote himself with renewed zeal to scientific work, visiting Europe at frequent intervals to confer with his scientific friends at the French capital, and gather objects of interest, especially in the department of Meteors, to the study of which, as is well known, he devoted much time and contributed many important memoirs. The subject of his last paper, in June of 1883, was "On the Concretions in Meteoric Iron," detailing new methods of research, of which he says, "if my health permits I shall complete them before many months." These were his last published words! Fortunately for science his very large and fine collection of Meteorites was purchased by Harvard University only a few days before his death.

Few have done so much for American mineralogy as Dr. Smith, and done it so well. His works were widely recognized, and few Americans have been rewarded by so many elections to learned societies. The following list embrace the more important both domestic and foreign:

Member of the American National Academy of Sciences; of the Chemical Society of Berlin; of the Chemical Society of Paris; of the Chemical Society of London; of the Societe d'Encouragement pour l'Industrie Nationale; of the Imperial Mineralogical Society of St. Petersburg; Corresponding Member of the Boston Society of Natural History; of the American Academy of Arts and Sciences; of the American Philosophical Society; American Bureau of Mines; the Societe des Sciences et des Arts de Hainaut, etc. Chevalier de la Legion d'Honneur; Member of the Order of Nichan Iftahar of Turkey; Member of the Order of Medjidieh of Turkey; Chevalier of the Imperial Order of St. Stanislas of Russia: correspondent of the French Institute.

All who knew Lawrence Smith loved him. He was one of the most amiable of men and yet a strong character. One who knew him well says justly of him: "Eminent in his profession he was more than eminent in his home. He was a gentleman, truly, but he was a man of affairs, a man of convictions, a man among men, who though absorbed in scientific pursuits, took a sincere and profound interest in public questions and events. He had not an enemy on earth, despite the positivity and transparency of his opinions, and he goes to his last rest leaving the people with whom he was so long identified to mourn the loss of a citizen of whom all were proud and whom everybody loved and honored." B. SILLIMAN.

ABSTRACTS.

Abstracts from *Journal of the London Chemical Society.* By E. WALLER, Ph.D

Contributions to the Chemistry of Tartaric and Citric Acid. Compiled form the manuscripts of B. R. GROSJEAN by R. WARINGTON. (XLIII., p. 331). Different specimens of powdered citric acid lost water of crystallization, by drying over oil of vitriol, very unequally. Of these specimens one lost all its water in 15 days, another in 24 days, while another scarcely lost the whole in 60 days. The cause seems to be different conditions prevailing at the time of crystallization.

M. Grosjean's method for determining "precipitable acid in lemon juice, &c., in—neutralization with soda, addition of calcium chloride, and boiling in a salt or glycerine bath. After filtering off the first precipitate, the filtrate and washings are neutralized with dilute ammonia and concentrated. A second concentration is also made. The precipitates are ignited, and the amount of citric acid calculated from the neutralizing power of the resulting calcium carbonate. The proportion of free acid determined by acidimetry, is usually slightly in access of the amount of precipitable acid in lemon juice, bergamot juice and lime juice, the ratio being 91 to 103 of precipitable to 100 of free acid. In orange juice it is about 19 per cent. precepitable to 100 of free. Specific gravity is not a safe guide for the value of lemon juice.

The prolonged concentration of tartaric acid per steam causes a partial conversion of the acid into meta tartaric acid. By diluting and boiling the solutions, or allowing them to stand for some time in the cold, the reverse change takes place.

The presence of free sulphuric acid, diminishes very much the solubility of tartaric acid in water.

A hot saturated solution of tartaric acid deposited 50 per cent. of its acid on standing in the cold for some days. With the addition of 100 volumes of brown oil of vitrol (Sp. gr. 1,713) 70 per cent. of the tartaric acid present was deposited.

Note on a Basic Ammonio Copper Sulphate. S. U. PICKERING. (Vol. XLIII, p. 336).

On adding ammonia to a nearly saturated solution of copper sulphate until the composition was about $Cu\,SO_4$, $3\,N\,H_3$ and allowing it to stand, a violet blue deposit separated probably consisting of $Cu\,SO_4\,4\,NH_3$ with some neutral sulphates. On diluting this solu-

tion, a dark violet blue compound, $Cu\,SO_4\,3\,Cu\,O\,2\,NH_3\,5\,H_2O$, separated.

A table of the series of analyses made on this precipitate, is given.

Note on the action of Sulphuric Acid (Sp. Gr. 1.84) upon Potassium Iodide. H. JACKSON. (Vol. XLIII., p. 339). It was found that when the sulphuric acid was present in large excess the reaction $2\,KI + 3H_2\,SO_4 = 2I + 2KHSO_4 + 2H_2O$ occurred, whereas when the sulphuric acid was only just sufficient to neutralize the potassium, it was :

$$8\,KI + 9\,H_2\,SO_4 = 8\,I + H_2S + 8\,KHSO_4 \times 4\,H_2\,O$$

I. **Laboratory Notes.** J. H. GLADSTONE and A. TRIBE. (Vol. XLIII., p. 341.)

1. **On the action of Light and Heat on Cane and Invert Sugars.** An attempt to obtain alcohol and carbonic anhydride from sugar solutions by the action of the copper zinc couple, though apparently successful, by close investigation was found to have been altogether unsuccessful. The CO_2 obtained (at 100° C) came from the splitting up of an oxy-carbonate of zinc, while no alcohol was formed, though a substance distilling over and affording the iodoform test, appeared. Heating alone caused a gradual darkening of the sugar solutions, with formation of this substance, together with glucose and some substance acid to test paper. Light appeared from the experiments made to be detrimental to fungoid growths in cane sugar solutions.

II. **Hydroxylamine.** The color produced with this substance and the Nessler reagent resembles that with ammonia when the solution is very dilute. More concentrated solutions give darker colors and precipitates. The hydroxylamine is rapidly converted into ammonia by the zinc copper couple.

III. **Recovery of Iodine from Organic Iodide Residues.** By use of the zinc copper couple the iodine is converted into zinc iodide from which the iodine may be separated by the use of bleaching powder.

IV. **A Residual Phenomenon of the Electrolysis of Oil of Vitriol.** After electrolyzing oil of vitrol it was observed that oxygen gas was evolved from the electrodes long after the current had been broken. It was found to be due to the presence of persulphuric acid.

v. **On alleged tests for Alcohol.** The iodoform test was found to be fallacious. Also the test described by Davy with molybdic acid in sulphuric acid. The blue color may be obtained by several other reducing agents.

vi. **Reaction of the Copper Zinc Couple on Nitric Oxide.** Ammonia was the result of the reaction when the gas was passed over a moistened zinc copper couple. Negative results so far were obtained with free nitrogen.

vii. **On the reducing action of Spongy Lead.** Lead precipitated by zinc from the acetate containing presumably no hydrogen rapidly reduced potassium nitrate to the nitrate. The action was accelerated by heat, and retarded by the presence of sulphuric acid. The lead had no action on solution of potassium chlorate except in the presence of 1 per cent. of $H_2 SO_4$ when it slowly changed to chloride.

The action of Nitrous Anhydride on Glycerol. O. Masson. (Vol. XLIII., p. 348.) On passing nitrous anhydride into glycerol which is kept cold, the liquid increases largely in bulk, and divides into two layers. The smaller layer consists of an aqueous solution of nitrous acid, and various oxidation products of the glycerol. The other layer was found to be impure glyceryl tri-nitrite. [$C_3 H_5 (NO_2)_3$]. It was purified by repeated distillation over a water bath in a current of hydrogen. It is a mobile volatile liquid of gr. 1.291 distilling at about 150° C. It burns with whitish flame but does not explode under the hammer. It is decomposed by water, nitric oxide gas being evolved. The experimenter was unable to keep the liquid long without decomposition, as it was so very unstable.

On the preparation of the Pentathionates. S. Shaw. (Vol XLIII., p. 351). After obtaining the Wackenroder solution by passing H_2S and SO_2—(the latter slightly in excess) for 32 hours through distilled water, the solution was neutralized with normal caustic potash, and after concentrating, the solution was placed in partial vacuum over sulphuric acid. The successive crops of crystals contained :—

1st Crop	K:S = 2:4	
2d "	K:S = 2:4	
3d "	K:S = 2:4.6	Mixed.
4th "	K:S = 2:4.6	
5th "	K:S = 2:4.6	
6th "	K:S = 2:5	Selected.

The first crystals gave clear solutions not rendered turbid by addition of Na HO. The last crops of crystals dissolved clear, but the solution become turbid from separation of sulphur on addition of Na HO. A crystallographic description of the crystals is given.

Note on the action of Allylic Iodide upon Phenol in the presence of Lime or Aluminium Foil. P. F. Frankland and F. Turner. (Vol. XLIII., p. 354). Propyl phenol was the result of the reaction with separation of hydriodic acid and free iodine. The probability seems to be that allyl phenol is first formed, which is converted into propyl phenol by the action of the hydriodic acid.

Note on Pentathionic Acid in connection with the foregoing paper. W. Smith. (Vol. XLIII., p. 355). The peculiar fact that the Wackenroder solution when freshly prepared is precipitated by both acids and alkalies, sulphur separating in each case, but after neutralization does not present this phenomenon, being precipitated by acids but not by alkalies, is explained by the fact that at first the free sulphurous acid is present, affording the necessary condition for the formation of a clear solution of thiosulphate. After evaporation the sulphuric acid is driven off, and the pentathionates left give precipitates with both alkalies and acids.

On a by-product in the manufacture of Aurin. A. Claparede and W. Smith (Vol. XLIII., p. 358). In preparing aurin by heating together phenol, oxalic and sulphuric acids, a white sublimate appears, which is decomposed by water and by alcohol, with liberation of phenol. They were found to be phenol ortho-oxalic ether. $C_2H_2O_4 + 2\,C_6H_5\,OH$. It is suggested that in the formation of aurin after the formation of phenol sulphonic acid, the oxalic acid unites with the phenol to form the above compound while the sulphonic groups are again separated. In the succeeding stage the action of the sulphuric acid eliminates formic acid and water thus :

First stage. $H_2\,C_2\,O_4 + 2\,[HO\,C_6\,H_4\,SO_3\,H] + H_2O = C_2\,H_2\,O_4\,(C_6\,H_5\,O)_2 + 2\,H_2\,SO_4$

Second stage. $C_2\,H_2\,O_4\,(C_6\,H_5\,O)_2 + C_6\,H_5\,OH = C\,(C_6H_4)_3\,(OH)_2\,O + H\,COO\,H + 2\,H_2\,O$

On Samarium and its compounds. P. T. Cleve. (Vol. XLIII., p. 362). The laborious method of separating the samaria is described in detail. The atomic weight of samarium was determined from the sulphate believed to be $Sm_2\,(SO_4)_3$. The average

of six experiments gave in round numbers 150. The results of observations of de Boisbaudran and Thalin on the absorption spectrum of this element in combination is also given. The oxide is white, its salts more or less intensely yellow. Analytical results on the chloride, chloroplatinate, platino-cyanate, nitrate, acetate, sulphate, selenite and oxalate are given, as well as of the samarium potassium sulphate $2\ Sm_2\ (SO_4)_3\ 9\ K_2\ SO_4 + 3\ H_2O$ and samarium ammonium sulphate $Sm_2\ (NH_4)_2\ (SO_4)_4 + 8\ H_2O$. The element appears to be more closely related to didymium than to any other element.

On the rate of decomposition of Ammonium Nitrate. By V. H. Veley. (XLIII., p. 370.) The results of numerous experiments are given in detail. The conclusions are :

I. The rate or decomposition of ammonium nitrate into nitrous oxide and water is dependent not only upon the mass of salt undergoing decomposition, but also upon the proportion of free nitric acid present.

II. If the reaction of the salt be rendered alkaline at starting, the rate of decomposition gradually increases while the proportion of free acid increases ; a period of maximum velocity is then reached, corresponding to the greatest proportion of free acid ; from this point the rate decreases very slowly, while the proportion of free acid also decreases.

III. An excess of ammonia obtained either by passing in gas, or by the addition of a basic oxide, will completely stop the reaction, even at temperatures 50-60° above the normal point of its decomposition.

IV. If the reaction of the salt be rendered acid at starting, the rate of decomposition gradually decreases, while the proportion of acid gradually decreases.

V. After heating the salt for about 13—16 hours the rate of change becomes practically constant.

On Evaporation in Vacuo. H. McLeod. (XLIII., p. 384.) The paper is unintelligible without the accompanying figures. The idea of the apparatus was suggested by Wrights (Chem. News, XLIV., 311.) and the apparatus devised resembles closely that described by Prof. Mallet (ib XLVII., 218, 252) though it was constructed and used before the appearance of the last named paper.

Violent ebullition of the water is one great difficulty in the process. The evaporation is slower than by the ordinary method being at the rate of about 50c.c. in 2 hours. By the use of sulphuric

acid to absorb the evaporated water the operation can be conducted at only a few degrees above freezing.

On the Specific Gravity of Parraffin, Solid, Fused and in Solution. G. Beilby. (XLIII., p. 388). The paraffin used was carefully purified by repeated crystallization from shale naphtha, steaming and filtering through bone black. It fused at 38°. The results were :

Sp. Gr.	Solid at 21°	874.0
	Dissolved at 21°	795.4
	Fused, (calculated to 21°)	795.6

The solvent used was a paraffin oil of Sp. Gr. 885, at 15.5°.

On Homologous Spectra. By W. N. Hartley. (XLIII., p. 390). The results of an interesting study of the harmonic relations between lines and groups of lines in the spectra of some of elements, magnesium, zinc, cadmium, copper, silver, aluminium, boron and silicon.

Thioxalic Ether. H. F. Morley. (XLIII., p. 400). By adding mercaptan in small quantities at a time to chloroxalic ether, the mixture being kept cold in ice water, and afterward boiling off the HCl formed, and finally distilling, some chloroxalic ether first comes off at 128°. After that the temperature quickly rises to 210 and above, the distillate containing the thioxalic ether. This is purified by repeated distillation. It is a colorless liquid with a faint odor like that of garlic. Sp. Gr. at 10° 1.1446. Boils at 217° C (Corr). It is decomposed by caustic potash solution affording potassum oxalate, mercaptan and alcohol. A similar decomposition slowly takes place in water alone.

The results of analysis were :

	Found.	Theory for $C_6H_{10}SO_3$	
C	44.41	44.24	44.44
H	6.28	1.33	6.17
S	19.24		19.75

The combustion was effected with a mixture of copper oxide, and lead chromate. For the S a modification of Plimpton and Graves's method for chlorine, (Jour Lond Chem Soc., XLI., 119) was used. The method of Carius gave only about 0.1 per cent. S.

Ammonia gas converts thioxalic ether into mercaptan and oxamethane.

An attempt to obtain potassium thio ethyl oxalate by the

action of alcoholic potash on this substance in alcoholic solution resulted in the formation of potassium ethyloxalate and mercaptan.

On the Condensation Products formed by Benzoïc Aldehyde with Malonic and Isosuccinic Acids. Chas. M. STUART. (XLIII., 403.)

Perkin, in investigating the phenomena of condensation occurring between aromatic aldehydes and bodies of the acetic series of acids made use of an anhydride with the sodium salt of the acid, and expressed his belief that the condensation took place between the aldehyde and the anhydride, the sodium salt playing only a secondary part. After a review of the results obtained in regard to this question by Fittig, Payne, Tieman and Claisen, the author gives the results obtained by himself which go to show that the condensation takes place with the sodium salt.

He also finds incidentally that the statement in *Watts' Dictionary* that ethyl cinnamate is scarcely attacked by fuming nitric acid, is erroneous.

A Contribution to the History of the Constitution of Bleaching Powder. L. TRAUT O'SHEA. (XLIII. 410.) The methods and results of various experiments are given in detail, The conclusions are :

1. That the excess of hydrate present in bleaching powder, is not a constant quantity.

2. That the formula of the bleaching compound is

$$Ca\,(O\,Cl)_2 + Ca\,Cl_2$$

3. That by the action of water this compound undergoes the following decomposition :

$$2\,Ca\begin{cases} O\,Cl \\ Cl \end{cases} = Ca\,(O\,Cl_2) + Ca\,Cl_2$$

By *bleaching compound* the author designs to designate the compound at the expense of which oxidizing takes place, as distinguished from *bleaching powder* which is the substance obtained by the action of chlorine on calcium hydrate.

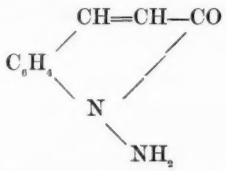
Abstracts from "*Berichte der deutschen chemischen Gesellschaft,*" by Percy Neymann, Ph.B.

On phtalylacetic-acid-ether. E. Fischer, and H. Koch, (Vol. XVI., p. 651). Phtalylchloride and sodio-acetic-acid-ether act upon each other at ordinary temperature. The reaction is about as follows :

$$C_6H_4, C_2O_2Cl_2 + 2\,Na\,C_6H_9O_3 = 2\,NaCl + C_6H_{10}O_3 + C_6H_4, C_2O_2, C_6H_8O_3$$

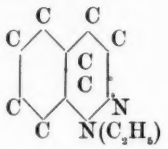
The last compound is called phtalyl-acetic-acid-ether. It is colorless, crystallizes in prisms which have the melting point 124° C. Succinyl chloride acts in the same manner with sodio-acetic-acid-ether.

On Chinazol Compounds. E. Fisher and Hans Kuzel (Vol. XVI., p. 652). Ortho-hydrazin-cinnamic-acid is easily converted into the anhydride corresponding to carbostyril :



In order to determine if it is possible for a ring connection to exist between carbonyl and the second nitrogen atom of the hydrazinin group, ethylated hydrazinin-cinnamic-acid was examined. It was hoped to obtain this substance by reduction of the nitroso-ethyl-amido-cinnamic acid.

By reducing with zinc dust and acetic acid nitrosamin does not give hydrazin, but is converted into a carbon-acid of the formula $C_{10}H_{11}N_2$—COOH by losing one atom of oxygen. This acid is decomposed by heat into carbonic acid and a base of the formula $C_{10}H_{12}N_2$. This has no similarity with hydrazinin, but reminds of chinolin. It probably has the constitution



The authors have called it "Ethyl-chinazol," and the corresponding acid "Ethyl-chinazol-carbon-acid."

On a Reaction of Aldehydes. F. Penzoldt and Emil Fisher. (Vol. XVI., p. 657). When mixing diabetic urine with an alkaline solution of diazobenzol-sulfonic acid a red color was observed after 10—15 minutes, which gradually assumed a violet color. The same reaction was observed in a solution of pure grape sugar, and investigation showed that this was a reaction common to aldehydes. In the case of stable aromatic aldehydes the reaction only takes place by addition of sodium amalgam.

On the Compounds of the Hydrazins with Ketones. H. Reisenegger. (Vol. XVI., p. 661). Phenylhydrazin combines with the various ketones at ordinary temperature in the proportion of equal molecules, by giving off water. The products are constant in the presence of water and alkalies, but are easily reconverted into the generators by acids. The same reaction can be executed with secondary hydrazins.

On Cinnolin Derivatives. V. v. Richter. (Vol. XVI., p. 677). The investigation was undertaken with the idea of preparing ortho-oxy-acteo-phenon $C_6H_4(OH)\ COCH_3$ from ortho-nitro-phenyl-propiolic acid, in order to arrive at the synthesis of alpha-cumaric acid. However, the investigation led to something entirely different, by exhibiting a new group of compounds which are to be regarded as derivatives of a substance $C_8H_6N_2$, which, because of its analogy with chinolin the author has termed cinnolin.

$$C_6H_4\begin{cases}CH:CH\\N:CH\end{cases}$$

Chinolin.

$$C_6H_4\begin{cases}CH:CH\\N:N\end{cases}$$

Cinnolin.

The cinnolin can be regarded as a chinolin in which the CH group tied to oxygen is replaced by a nitrogen atom ; it contains a six-jointed closed ring consisting of four carbon and two nitrogen atoms.

On Sulphonic Acids of Hydrochinon. A. Seyda. (Vol. XVI., p. 687). After having prepared hydrochinon by Nietzki's method, the author prepared the hydrochinon-mono-sulphonic acid and hydrochinon-di-sulphonic acid. To obtain the mono-acid one part of hydrochinon is heated with 8 parts of mixed sulphuric acid at 50° C. for three hours with constant stirring. After 24 hours the mono-acid as a rule crystallizes out. The barium, zinc, and potassium salts are easily prepared.

The hydrochinon-di-sulphonic acid is prepared by dissolving one part of hydrochinon in 5 parts of fuming sulphuric acid and heated at 100° to 110° for one hour. The acid gradually separates, and

after cooling a thick, sticky mass is produced. The free acid is obtained by precipitating the barium from the barium salt with sulphuric acid. It crystallizes in long thick needles. It has an astringent taste and effloresces in the open air.

On Nitro-amido and Oxy-methyl-anthrachinon. H. Roemer and W. Link. (Vol. XVI., p. 695). For some time past there is found in crude anthracene at times a higher homologe termed methyl-anthracene. It is especially found in the American product and is very stable. Oxidation produces methyl-anthrachinon, and even after sulphurizing and subsequent fusion with caustic soda the methyl group is not eliminated. Nitromethyl-anthrachinon is prepared by dissolving two parts of methyl-anthrachinon in conc. sulphuric acid and adding one part of nitric acid sp. gr. 1.48. The color changes from original red to yellow and a crystalline precipitate gradually deposits. After 24 hours the mass is poured into water, the product crystallizes and is purified from acetic acid. The melting point is at 269° to 270°. the formula is

$$C_{14}H_6O_2\begin{cases}CH_3\\NO_2\end{cases}$$

Amido-methyl-anthrachinon is prepared by reducing the nitro compound with alkaline solution of stannous oxide. The amido compound melts at 202°. It is dark red in color and crystallizes in needles. The formula is

$$C_{14}H_6O_2\begin{cases}CH_3\\NH_2\end{cases}$$

Acetyl-amido-methyl-anthrachinon crystallizes in bright red needles, melts at 176° and 177° and has the formula

$$C_{14}H_6O_2\begin{cases}CH_3\\NH, C_2H_3O\end{cases}$$

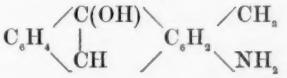
Acetyl-oxymethyl-anthrachinon crystallizes from alcohol in orange colored needles of the melting point of 177°, and the formula is

$$C_{14}H_6O_2\begin{cases}CH_2\\O, C_2H_3O\end{cases}$$

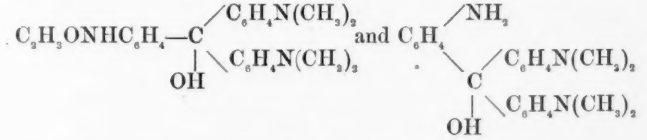
It is remarkable that all these derivatives have approximately the same melting point :

Methyl-anthrachinon	177°
Acetyl-amido-methyl-anthrachinon . .	176°–177°
Oxy-methyl-anthrachinon . . .	177°–178°
Acetyl-oxy-methyl-anthrachinon . .	177°

Amidomethylanthrol. H. ROEMER and W. LINK. (Vol. XVI., p. 703.) If amido-methyl-anthrachinon is heated with hydroiodic acid of sp. gr. 1.7 and red phosphorus to boiling for one hour, then water added and washed until ammonia no longer produces a precipitate in the filtrate very little substance remains on the filter. This compound is difficult to obtain. The reaction is entirely different when hydroiodic acid is used of the sp. gr. 1.96. If amido-methyl-anthrachinon and half of its weight in red phosphorus are heated with this on a water bath for one to two hours very little substance will go into solution. The residue is soluble in dil. hot hydrochloric acid and conc. hydrochloric acid precipitates yellow needles, the hydrochloric acid salt of a base. Washing with water separates the acid and leaves a base, melting at 183° C. The formula, according to analysis, was found to be ($C_{15}H_{13}NO$). The compound is called amido-methyl-anthrol



On the Violet Derivatives of Triphenylmethane. O. FISCHER and L. GERMAN. (Vol. XVI., p. 706.) The authors assume, contrary to former investigations (Berichte, XII.,800) that the base of methyl violet contains six methyl groups, and they base their opinion on the results obtained by boiling acetyl-tetramethyl-para-rosanilin with conc. hydrochloric acid. Acetyl is separated and the violet obtained is the same as that obtained by direct oxidation of tetramethyl-para-leukanilin with chloranil.



Acetyl-tetramethyl-para-rosanilin (green). Methyl violet.

On Tetra-Hydro--Chinolin. L. HOFFMANN and W. KOENIGS. (Vol. XVI., p. 727.) It is prepared by heating on a water bath a solution of one part of chinolin in about thirty of strong hydrochloric acid and gradually adding three to three-and-a-half parts of granulated tin. The excess of acid is driven off and after addition of concentrated solution of caustic alkali steam is driven through the resulting mass carrying chinolin and tetra-hydro-chinolin with it. To

separate these, gaseous hydrochloric acid is led into the dry ethereal solution and the precipitate recrystallized from alcohol. Tetrahydrochinolin is solid at winter temperature in the form of colorless needles. It boils at 244°–246°. The author has prepared a number of important derivatives.

On some new Glyoxalines. Br. Radziszewski. (Vol. XVI., p. 747.) The author, according to a former communication, shows that glyoxalin is the first member of an homologous series Cn $H_2n-_2N_2$, which are produced by the action of ammonia upon a mixture of glyoxal and aldehydes, or by the action of compounds

$$C_nH_{2n-2}-CH\begin{matrix}OH\\NH_2\end{matrix}$$

upon glyoxal. In this way he has produced glyoxal-isobutylene $C_6H_{10}N_2$ from glyoxal and isobutyl-aldehyde. Glyoxal-isoamylin $C_7H_{12}N_2$ from glyoxal and valeraldehyde. Glyoxal-isoœnanthylin $C_9H_{16}N_2$ from glyoxal and œnanthol ammonia.

On Dinitro-Cinnamic Acid. T. Friedlander and J. Maehly. (Vol. XVI., p. 848.) Dinitro-cinnamic-acid-ether was prepared by adding para-nitro-cinnamic-acid-aldehyde into a mixture of sulphuric acid and fuming nitric acid at 20°–30°. The methyl ether is similarly prepared. The analysis corresponded to the formula

$$C_6H_4\begin{matrix}CH=C(NO_2)CO_2C_2H_5\\NO_2\end{matrix}$$

Dinitro-cinnamic acid

$$C_6H_4\begin{matrix}CH=C(NO_2)COOH\\NO_2\end{matrix}$$

is produced when para-nitro-cinnamic acid in solution of conc. sulphuric acid is introduced into cooled nitric acid. The temperature must not rise above 10° C. The acid is decomposed in ice water, and no salts could be isolated. When the acid decomposes it sets free carbonic acid and forms dinitro-styrol

$$C_6H_4\begin{matrix}CH=CHNO_2\\NO_2\end{matrix}$$

which melts at 199° C.

Abstracts—*Zeitsch. für Anal. Chemie.*, by F. P. Venable, Ph. D.

Determination of Nitrogen in Organic Bodies. By J. KJELDAHL. (Zeitsch. Anal. Chem., 22.366). The author proposes to substitute an oxidation, by means of permanganate, of the organic substance in acid solution for the oxidation in alkaline solution as in the process of Wanklyn.

The sample is first strongly heated with sulphuric acid (concentrated). Nearly all substances are thus brought into a condition in which the nitrogen can be completely converted into ammonia. The principle of this conversion is to heat the substance with a sufficiency of sulphuric acid to a temperature near the boiling point of the acid, and then to oxidize the solution thus obtained by means of an excess of dry powdered permanganate. The nitrogen present in the organic compounds is under these circumstances completely converted into ammonium sulphate. After the oxidation and a supersaturation with soda, the liquid can be distilled off and determined according to the usual methods. It is essential for this process that the ammonium sulphate suffer no decomposition by the high temperature and subsequent treatment with potassium permanganate, which is attended with a very violent reaction. Several experiments gave proof that no such decomposition took place.

In carrying out the process, the substance is placed in a 100 c.c. flask with a long neck, and sulphuric acid is added in sufficient excess. It is then heated over a small flame. The liquid is at first black and tarry bnt finally clear. The heating lasts about two hours. The temperature should be a little below the boiling point. The permanganate is introduced in small portions, the flame being removed. The completion of process is known by the appearance of a green color. When sufficiently cool, water is added. It is introduced into the distilling apparatus, soda solution added (zinc turnings having first been added to prevent bumping), and the ammonia distilled over.

Nitrates in the presence of organic matter are converted into ammonia. The application of the process is doubtful where certain alkaloids and nitrogen in the form of volatile acids occur.

Estimation of Phosphoric Acid as Magnesic Pyrophosphate. By DAVID LINDS. (Chem. News, 48.217). The author used, in the experiments, microcosmic salt. The precipitates were made direct with magnesia mixture, 6 p.c. NH_3 added, and the washing done with 1.2 p.c. NH_3. The experiments were car-

ried out in sets of eighteen and averages taken. The following conclusions were drawn:

Moderate heating does not influence the results—precipitation at or near the boiling point gives results that are too high.

Large excess of magnesia mixture, if added gradually, does no harm. A large excess must be used in the presence of ammonium chloride, oxalate, or citrate. If added all at once the results are too high. If constantly stirred, 2 c.c. may be added at a time. When neutral magnesia mixture is used (prepared by boiling to expel ammonia) the precipitation is in complete until ammonia has been added. Results then accurate, and precipitate easily washed.

Precipitation in presence of much free ammonia gives a voluminous precipitate which is hard to wash. If ammonium citrate or oxalate is present the precipitate is crystalline and compact. Using a 2.5 p.c. NH_3 solution, the author finds its solvent action 0.0002 grm. per 100 c.c. used in washing.

Ammonium oxalate, citrate and chloride have a solvent action on the precipitate, and also, apparently, a power of hindering its formation. A large excess of magnesia mixture prevents both of these actions.

These results may be compared with the investigations of Ogilvie (Chem. News, 31.274, 32. s.12.70.).

Separation of Bismuth from Copper. By JULIUS LOWE. (Zeit. Anal. Chem. 22.495). Solutions of Bismuth and Copper are precipitated by potassium and sodium hydroxide, and completely redissolved in excess in presence of glycerine. On adding a solution of glucose, and heating, both are precipitated, the copper as cuprous oxide, and the bismuth as finely divided metal. If however, after addition of glucose the solution stands several hours in the cold, only the copper is precipitated (a little of the bismuth is deposited after several days). Quantitative experiments gave fair results.

Precipitation of Manganese by air loaded with Bromine-vapor. By WOLF. (Zeit. Anal. Chem., 22.520). Instead of the usual precipitation of manganese with bromine water, after iron has been removed by sodium acetate in iron-ore analyses, the author recommends the use of the corresponding ammonia-salts, and claims to avoid all danger of forming nitrogen bromide, the incomplete precipitation of the manganese, etc., as well as making a more rapid determination, by forcing or drawing

through the precipitation flask a stream of air which has first bubbled through bromine water ; 15 to 20 minutes suffices for complete precipitation even where the proprortion of manganese is large.

Behavior of Silver Chloride, Bromide and Iodine toward Bromide and Iodine. By PAUL JULIUS. (Zeitsch. Anal. Chem., 22.523). A series of experiments leads the author to believe that any halogen used in excess is capable of expelling any of the others from their silver compounds. Thus the iodide or mixture of silver iodide and bromide can be changed into the bromide if air loaded with vapor of bromine, is forced over them when fused. Silver chloride, too, is changed into bromide after 1–2 hours action of bromine vapor. A much longer time, (6–10 and 3–4 hours respectively), is required to substitute chlorine or bromine in their silver compounds by iodine.

Test for Gallic Acid. By SIDNEY YOUNG. (Chem. News 48.31.). When an aqueous solution of gallic acid is treated with a solution of potassium cyanide, a beautiful red coloration is produced, which, however, disappears after a short time, if the liquid is not disturbed, a brownish-yellow color being left. Pure tannic acid gives no coloration with potassium cyanide, but commercial tannic acid invariably contains a certain amount of gallic acid. The reaction is, however, feeble. The reaction serves them to distinguish between the acids, and detect gallic acid in presence of tannic.

Identification of Minute Quantities of Silver Cyanide. By C. L. BLOXAM. (Chem. News, 48.59). Precipitated silver cyanide is amorphous under the microscope. Warmed with a drop of ammonia, however, it will form distinct needle-like crystals. Silver chloride treated in the same way gives minute octahedra. The sulphocyanide also forms needles, but its absence can be proved by the ferric chloride test. These needles are obtained also by boiling with a strong solution of sodium carbonate or with dilute nitric acid.

An Indicator to Show the Neutral End-reaction in Alkalimetry and Acidimetry. By A. GAWALOVSKI. (Zeitsch. Anal. Chem., 22.397). The usual indicators enable one to determine when either alkali or acid is in slight excess. If one mixes alcoholic solutions of phenolphtalein and dimethyl-aniline orange, (so-called methyl orange), an indicator is obtained which becomes

deep red when alkali is in excess, and is tinged rose color by an excess of acid. If neither is in excess and the neutral-point has been reached, the solution has from the indicator a clear citron-yellow color. The changes of color require 4–5 seconds. The mixed solutions of the indicators remain for at least five days perfectly good.

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